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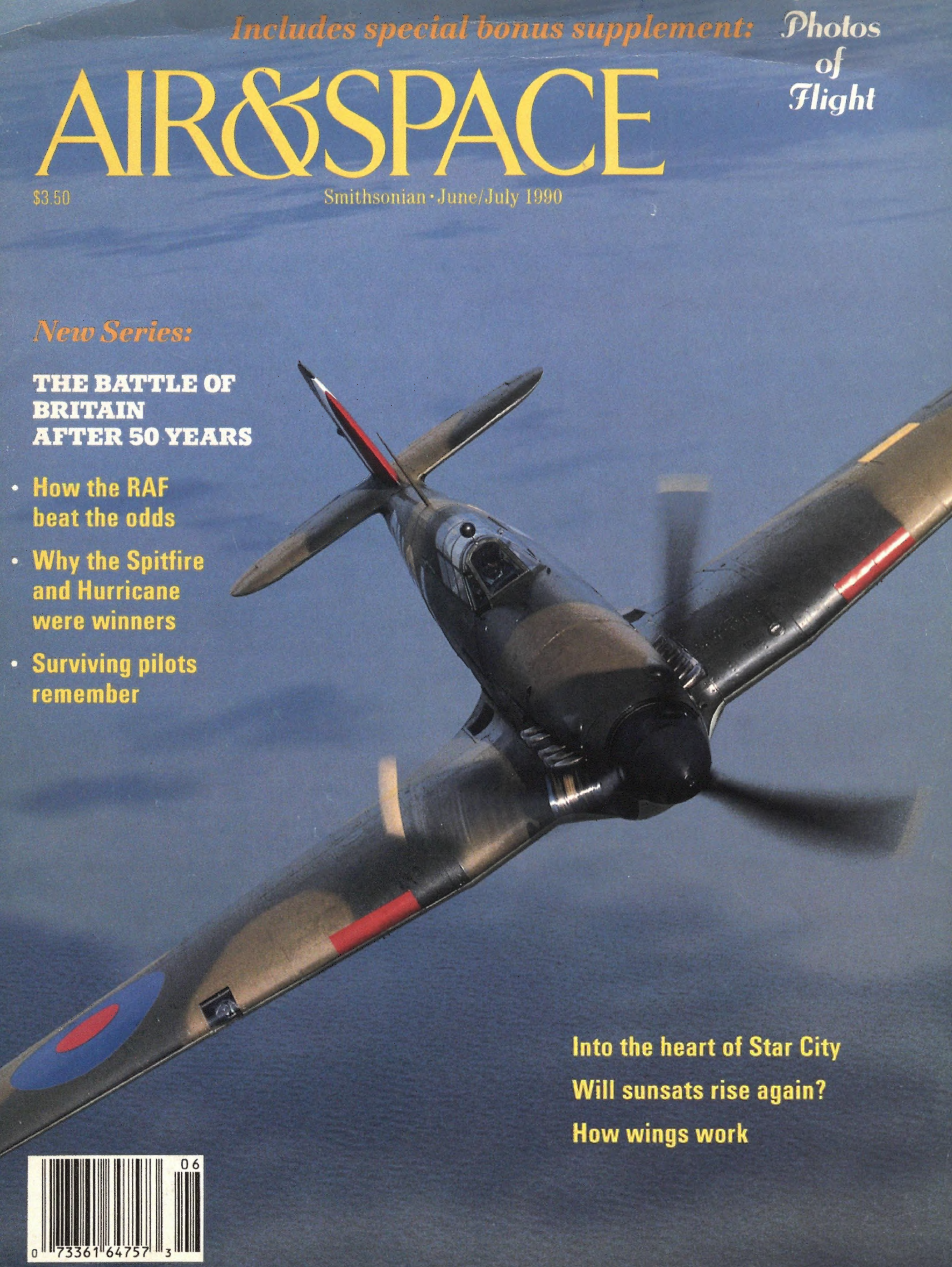

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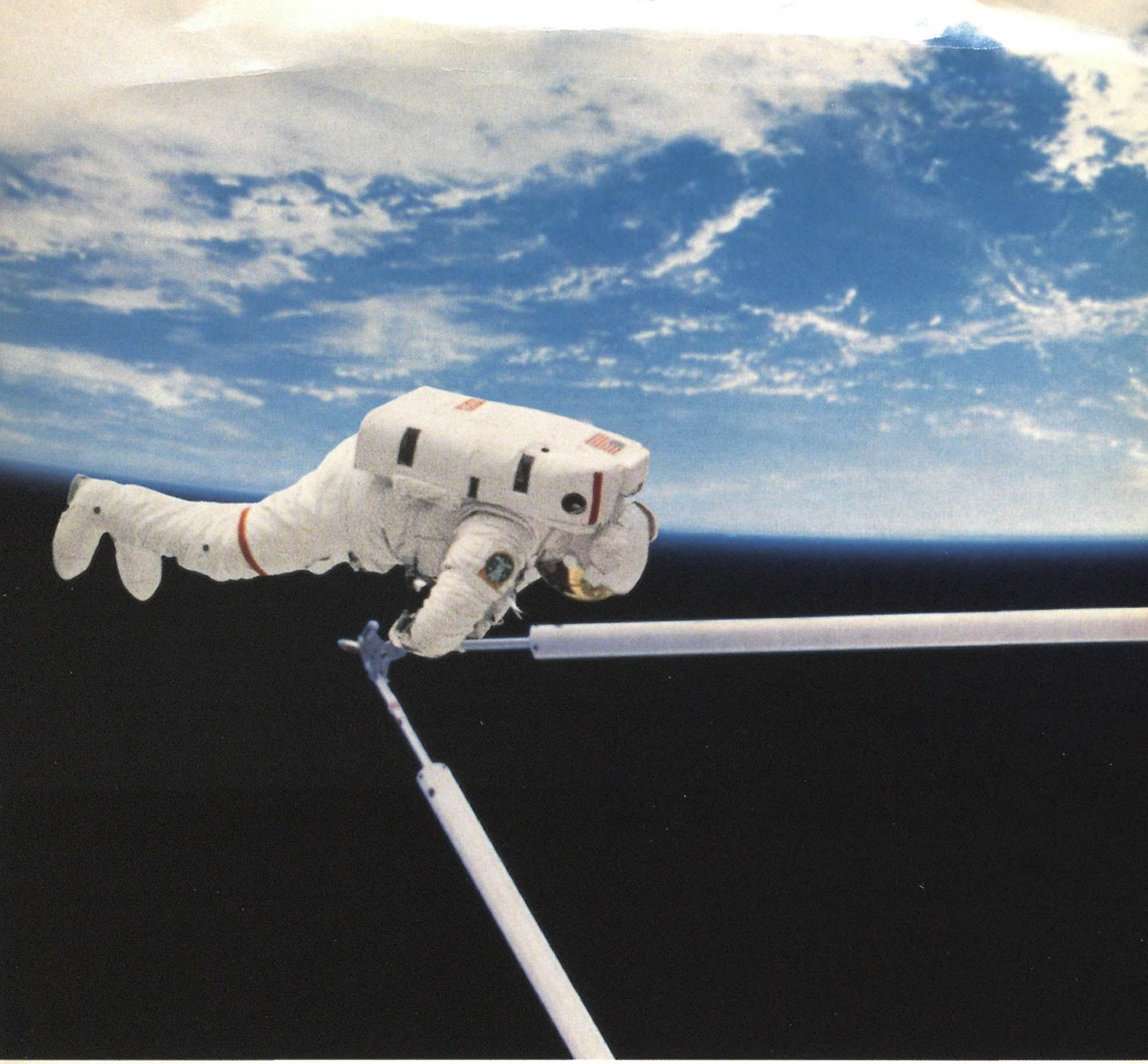

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June/July 1990
Volume 5, Number 2

AIR&SPACE

Smithsonian

Contents

Special Bonus Insert:
Photos of Flight
Classic images from the history of aviation.

36

68

82

26 Satellite Sleuths by Doug Stewart
Photographs by Patrick Ward

They hardly look the part, but members of the Kettering Group are pretty good detectives.

36 Inside Star City by James E. Oberg

Just an average community, really, except that the residents are cosmonauts.

46 Essay: A Call for Quality by Allen R. Stubberud

A message for engineers from a former Air Force chief scientist.

The Battle of Britain ***First in a Series***

50 The Last of the Few by Charles Fox
Illustrations by Ken Dallison

RAF pilots remember the view from their side of the first great air battle.

62 Improbable Journey by Dan B. McCarthy

Some said "impossible," but two Piper pilots proved them wrong.

68 300 Billion Watts, 24 Hours a Day by Linda Shiner
Illustrations by Paul DiMare

A solar-microwave public utility? All we have to do is pay for it.

76 Things in Wings by George C. Larson
Illustrations by David Clark

A paean to flaps, slots, spoilers—all very uplifting.

82 Return of the WASPs Story and portraits by Anne Noggle

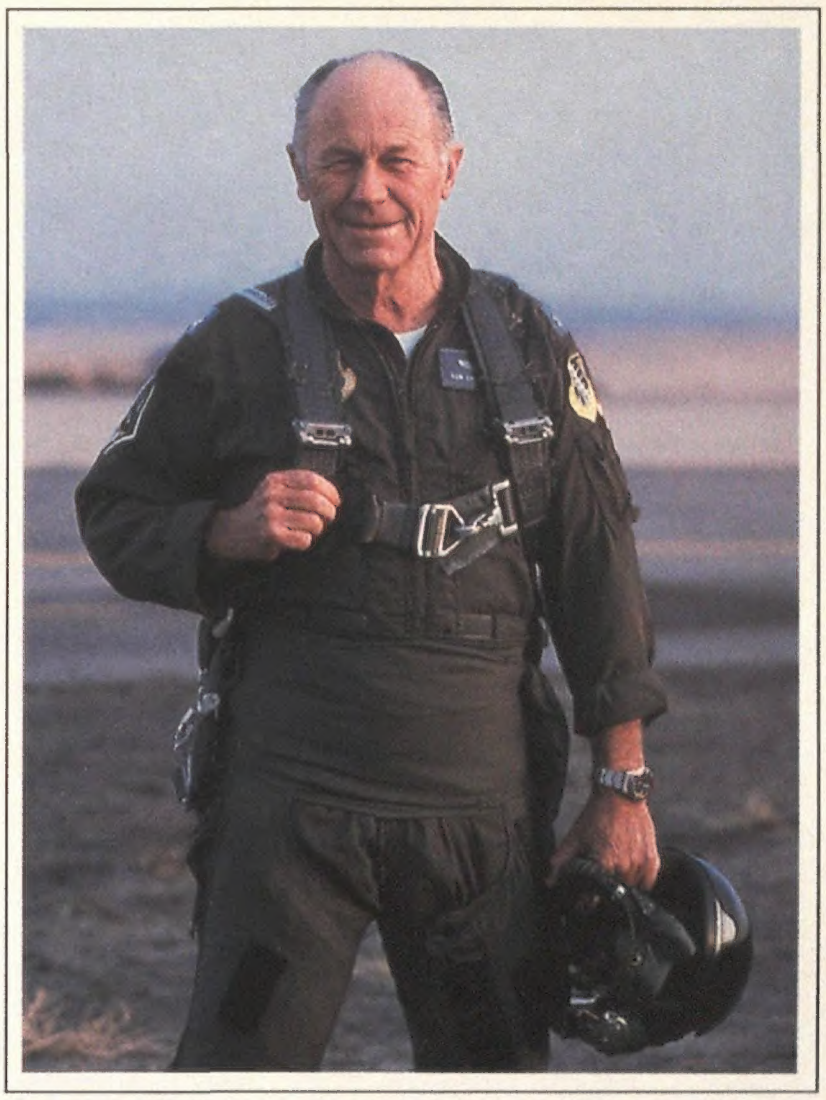
Women Airforce Service Pilots seen through one member's lens.

Departments

Cover:
Richard Winslade photographed the Luftwaffe-eye view of England's Hawker Hurricane.

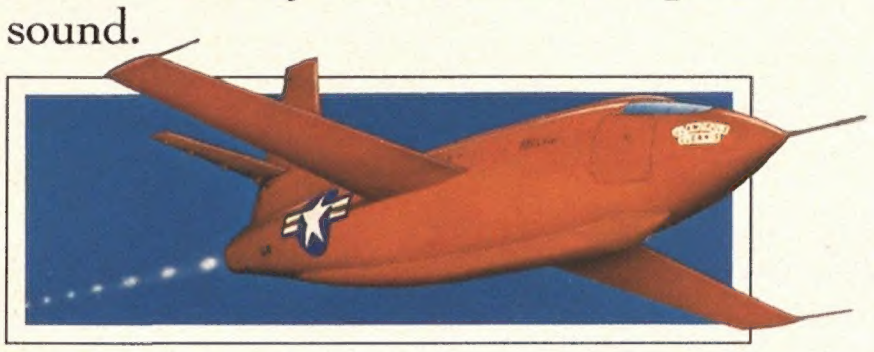
4 Viewport
6 Letters
10 Soundings
18 Oldies & Oddities
20 In the Museum
22 Above & Beyond
24 Flights & Fancy
88 Collections
90 Reviews & Previews
95 Credits
95 Calendar
96 "The Satellite Sky" Update
96 Forecast
96 Smithsonian Traveler

AIR & SPACE/Smithsonian (ISSN 0886-2257) is published bimonthly by the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560. Subscription price: $18 a year in U.S. possessions, $24 elsewhere. Eighty-five percent of dues is designated for magazine subscription. Single-copy price: $3.50. Second-class postage paid at Washington, DC, and additional entry points. Editorial offices: 370 L'Enfant Promenade SW, 10th Floor, Washington, DC 20024. Advertising and circulation offices: 420 Lexington Ave., New York, NY 10170. Members: Address all subscription correspondence and change-of-address information to P.O. Box 53261, Boulder, CO 80322-3261. Postmaster: Send address changes to *AIR & SPACE/Smithsonian*, P.O. Box 53261, Boulder, CO 80301-3261.



To the first man to break the sound barrier, Rolex is essential equipment.

Chuck Yeager first flew when he was 18. Three years later, he was a World War II ace. And at only 24, he became the first man to fly faster than the speed of sound.



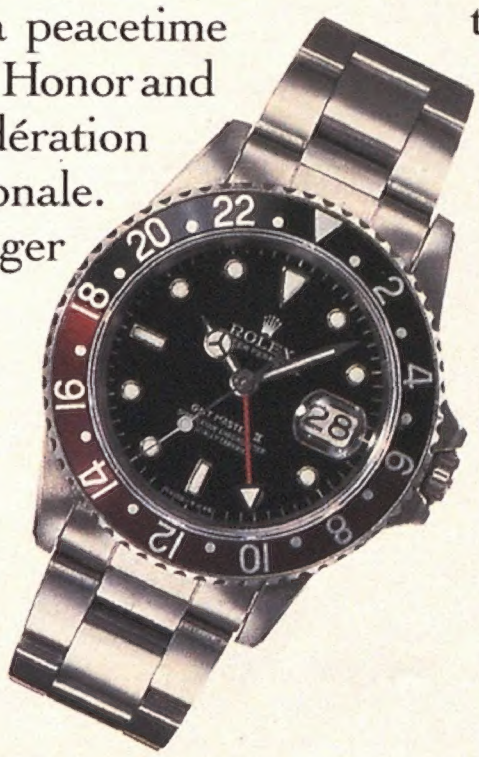
The Bell X-1, first to fly faster than the speed of sound.

An uncommon mix of drives and talents contributes to the general's achievements: the grit to press to the outer limits of speed, an insatiable lust for flight, extraordinary eyesight and reflexes, and an instinct for choosing the right equipment. Like the Rolex Oyster that has served him through 4 decades, even on punishing supersonic flights.

Now retired from the military, the general is still a man on the move. He's a consulting test pilot, a lecturer, and a lifelong outdoorsman with a passion for hunting and fishing.

Honors abound for such a man. His many awards include a peacetime Congressional Medal of Honor and the gold medal of the Fédération Aéronautique Internationale.

Today, General Yeager may well be America's most celebrated pilot. His exploits were featured in the Academy Award-winning film *The Right Stuff.* And his autobiography, *Yeager,* became a best-seller.



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Extending the Museum

On January 29 of this year, the Regents of the Smithsonian Institution selected a future site for the Extension of the National Air and Space Museum. It lies in a pleasant wooded corner of the Washington-Dulles International Airport.

Given the magnitude of this project, I thought I should tell readers about the kind of extension we hope to build. We want it to be an endeavor in which all of us can take pride—the Smithsonian Institution, the people of our nation for whom the facility will be built, visitors from abroad, and future generations of Americans who will come there to learn of our achievements.

The miracle of the 20th century has been our ability to take ancient dreams and see them as challenges; to take these challenges and wrestle them into realities; to take those realities and offer them up to everyman. Where Lewis and Clark struggled across our continent in 800 days, we now traverse their route in hours.

With similar ease we travel to distant continents, which we once knew only through atlases and schoolbooks. In the best of times we learn the customs of other men, begin to appreciate their aspirations, and benefit in mutual trade. In the worst of times, our dreams turn to nightmares as men of all nations go to war, and build powerful airplanes and missiles that carry destruction to the cities of their enemies.

These are stories of epic proportions. They are part of our 20th century *Odyssey* into air and space, and the Museum has taken on Homer's role of depicting that journey from Kitty Hawk to Hiroshima, and on to the lunar Sea of Tranquility. People from all nations come to the Museum to relive that story. They played a part in it. It affected their lives. They want their children to know how it happened.

Our achievements in air and space rank with the works of other great civilizations. My ambition is to preserve, for centuries to come, the airplanes and spacecraft which have played so pivotal a role in our time. With adequate shelter and intelligent care we too can succeed. But leave these airplanes—the *Enola Gay,* the shuttle *Enterprise,* the newly arrived SR-71—the fastest airplane in the world—outdoors, and they will soon deteriorate.

To continue to care for our collections and to chronicle the achievements of aviation and spaceflight, the Museum must physically expand.

We need an extension to exhibit the giant airliners which have widened the horizons of millions of people by opening the world to them. These aircraft cannot be brought into downtown Washington, would not fit into the present museum on the mall if they could, and would break through the floors of the building if brought inside.

We need the Extension to show the auxiliary systems which assure safety for the hundreds of millions of passengers who fly securely through our skies.

We need the Extension to talk of communications satellites of many countries linking all of us into a worldwide network—an emerging global civilization keeping itself informed.

We need the Extension to dramatize remote sensing satellites warning us of impending threats to our forests, atmosphere, oceans, and climate.

We need the Extension also to highlight surveillance satellites allaying international suspicions and perhaps helping to bring us history's first lasting peace between the great powers.

The view from space allows us to appreciate the world as an international civilization of people, all with rather similar aspirations but with different approaches and different emphases on values.

For all this to come to life at the National Air and Space Museum, we will need to build the Extension. With the support from our millions of visitors and our loyal *Air & Space/Smithsonian* readers we can make it happen.

—Martin Harwit is the director of the National Air and Space Museum. (This column is based on a talk given at a dinner sponsored by the Washington Airports Task Force to welcome the Museum and its future Extension to the Washington-Dulles International Airport.)

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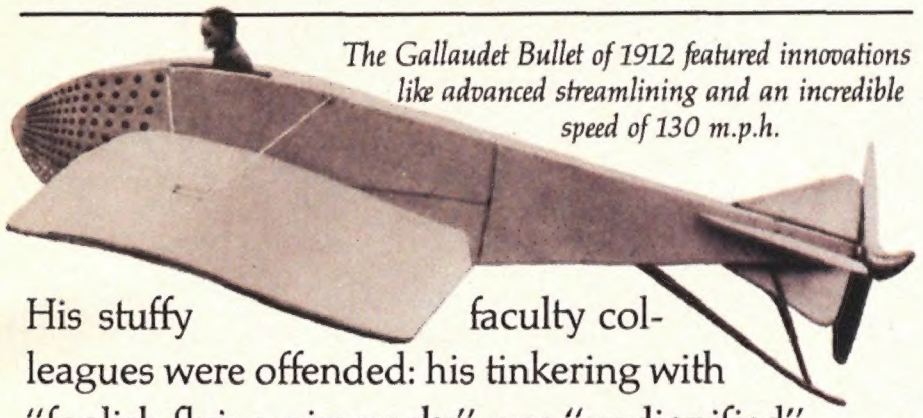
HE WASN'T A WRIGHT BROTHER. BUT HE HAD THE RIGHT IDEA.



The Gallaudet Bullet of 1912 featured innovations like advanced streamlining and an incredible speed of 130 m.p.h.

His stuffy faculty colleagues were offended: his tinkering with "foolish flying gimcracks" was "undignified."

But young professor Edson Gallaudet was willing to give up his dignity, and his job, for a new idea about warping the wings of flying machines.

In 1898, he tested a scale model which proved his idea right. And five years later, Wilbur and Orville Wright flew using that same principle.

In 1908, Edson Gallaudet started what many credit as the first aircraft factory in America. Gallaudet Engineering Company became the earliest aircraft ancestor of General Dynamics.

Over the next 82 years, our history of building aircraft has included some of America's famous planes. And famous people.

Eddie Stinson, barnstormer and "birdman," who designed aircraft for many of the pioneer pilots, merged his company with ours. As did Jerry Vultee, whose planes set many distance and speed records, including Jimmy Doolittle's 12-hour cross-country flight.

The RB Racer, made by Dayton-Wright Airplane Company, was the first aircraft to have fully retractable landing gear. Dayton-Wright became an early part of General Dynamics.

F-16s of the USAF Thunderbirds.

During WWII, the Consolidated B-24 Liberator became the most-produced American bomber. After the war, our B-36 Peacemaker became the backbone of America's Strategic Air Command.

Our innovative, delta-wing design made the F-102 the world's first supersonic interceptor. And the B-58 Hustler the world's first supersonic bomber.

Today our F-16 Fighting Falcon is rated the finest fighter in the world. It well represents our long tradition of craftsmanship and creativity.

Once again, that tradition is about to be tested. In a technology competition against groups from West Germany and Japan, General Dynamics is teaming with four top American companies to develop the National Aerospace Plane.

To fly from runway to orbit, at speeds up to 17,000 m.p.h., we must invent new science. We must also invent new ways for American competitors to work together. But we are confident.

Since the days of Gallaudet, our company has been inventing not only better airplanes, but better ways to make them.

GENERAL DYNAMICS

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Letters

The War Continues

Not least because I was selectively (but not inaccurately) quoted in it, I read Stephan Wilkinson's article "The Battle Over Warbirds" (April/May 1990) with considerable interest. Possessed as I am by a pilot's "natural arrogance," I could not resist finding out what I had to say. Predictably, I feel that my remarks to Wilkinson lost something in the translation.

For one thing, my comment about the fatal Spitfire crash comes across as dismissive, as if it were of no consequence because the aircraft was a "bitsa." On the contrary, it resulted in the tragic death of Charles Church, who will be greatly missed by many, the warbird community included. As for the lost hybrid Spitfire, it may not have had special historical significance but it was a flying Spitfire. Both from outside and inside the cockpit it accurately called forth the sensations associated with operating one of the most exhilarating creations of the machine age. From any point of view, the accident was an unmitigated disaster.

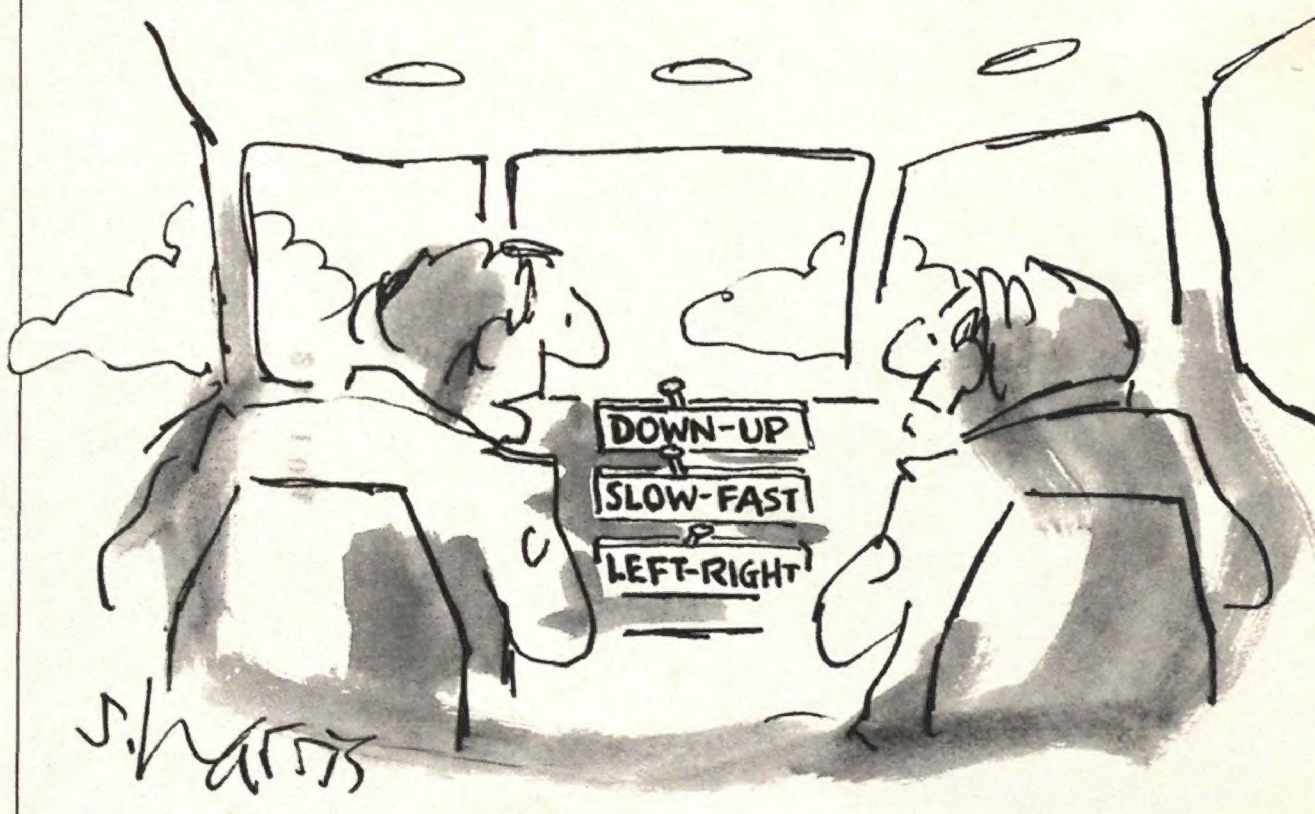
Having said that, I stand by my conviction that old aircraft deserve their place both in museums and in their natural element. In that regard, they are no different from old cars or locomotives. Accidents like those that destroyed the Church Spitfire and the Confederate Air Force's A-20 should not be used to argue for a prohibition of warbird flying. After all, we could reduce the general flying accident rate to zero if we stopped flying altogether. The answer is to ensure that the standards of competence demanded of pilots, technicians, and supervisors are as high as possible.

Air Vice Marshal Ron Dick
Royal Air Force (Ret.)
Woodbridge, Virginia

You just cannot ignore a screaming piston engine. To my ears, there is no more beautiful music.

J.B. Stokley
Opelika, Alabama

The last passenger pigeon is in a museum today, but the curators had the good grace



"Think you can handle it?"

to wait until it died before stuffing it. Airplanes are not built to drip oil into a coffee can in a building where all you hear is heels clicking on the floor; their aesthetics are in their motion and sound.

Ralph Jones
Aurora, Colorado

I feel very sad that our great fighters are almost all gone. I can tell you that what makes it sad for all of us World War II pilots is the fact that just about the only people who fly these great planes now are "junior birdmen."

Ben L. Brown
Monclova, Ohio

A position frequently argued by traditional museum professionals is that repairing or rebuilding aircraft from spare parts diminishes their historic significance. Haven't operational aircraft always required repair, parts, and engine changes to keep them flying? Are these aircraft too no longer historically significant?

Robert E. Ellis
Executive Director,
Kalamazoo Aviation History Museum
Kalamazoo, Michigan

An airplane belongs in the air. But if all we can manage—in light of the cost in dollars and sometimes human lives—are the static displays of museums, then let's restore and maintain them the best we can and keep them under cover. It's not the same as watching, hearing, smelling, and feeling, but it's better than pictures on a page.

Sonny Jones
Alexandria, Virginia

I am pleased to learn that I am not the sole proponent of preservation. The priority of flying the aircraft is an issue that led me to resign from the Confederate Air Force a few years back. I had the privilege of visiting a restoration shop of the Royal Air Force museum. A technician who was working on an aircraft remarked, "We intend that people 400 years from now will see these examples." The essence of restoration and preservation could not have been expressed more succinctly.

Howard E. Greenwell, P-51 pilot
355th Fighter Group, Eighth Air Force
Dallas, Texas

In Memory Of

I'm writing to pass on my reaction to "On Impact" (Groundling's Notebook, February/March 1990). You see, I was a good friend of Captain Charles Fulop, the pilot of the F-105 from George Air Force Base. In 1977 we were former F-4 guys going through F-105 transition at George. The accident happened in March 1978. Charlie did in fact stay with the aircraft to avoid the populated areas around Point Mugu Naval Air Station, where he experienced complete electrical failure while practicing instrument approaches.

Charlie was a true professional—one of the best pilots and leaders in the squadron. He was the only friend for whom I've been a pallbearer (most of my colleagues were killed in combat). For me too, the crash is "something I will always remember."

Lt. Col. Thomas J. Hanton
U.S. Air Force

Gender-Sensitive

In "Louisiana Red-Hot" (Collections, April/May 1990) you report that Marguerite Clark Williams owned and sold an airplane manufacturing company. What does her size have to do with her ownership? You describe Mary Haizlip as a star on the airplane racing circuit. What does her attractiveness to men have to do with her flying? Yet you quite gratuitously refer to Williams as "petite" and Haizlip as "drop-dead gorgeous." It is insulting to describe these women by their physical appearance when they are included because of their business activity and flying skill. Men in the article are described as "energetic" and "flamboyant."

Women own companies. Women fly planes. Women subscribe to your magazine. Show some respect.

Molly Anne Olds
Elkridge, Maryland

50 Missions

It was an exciting surprise to read the account of the January 7, 1944 bombing mission to Winter Haven (Above & Beyond, February/March 1990). I was the pilot of *Honky Tonk*, a B-24 in the 722nd Squadron of the 450th Bomb Group. We were the crew mentioned that bailed out in Yugoslavia but escaped with the help of the Partisans. We returned to our base two weeks later and completed our 50 missions. I must mention that the author, Jack Keil, was a great friend to have close by after a mission. He boosted spirits and morale with his songs, poetry, and keen sense of humor. We all loved him.

Robert H. McCarthy
Punta Gorda, Florida

What's So Funny?

Ivan Kelley's letter in the April/May 1990 issue ("Comic Relief") was not in the least bit humorous. It was insulting to the many pilots, students, and businesses who labored long and hard to help victims of the Northern California earthquake in the best way available to them. Since he lives several hundred miles from the affected area, Kelley was probably unaware of the fact that all roads leading to Santa Cruz and Watsonville were damaged. I watched agencies attempt to get needed materials into the area. One truck carrying vital materials took over 14 hours and two tanks of gas to make its delivery.

Thomas A. Young
Olema, California

The Zero Design: A Copy?

I enjoyed "The Zero: One Step Beyond" (February/March 1990) and remember quite well our prejudice against anything Japanese, which, as the article pointed out, clouded our judgment. However, I always felt that the Zero remarkably resembled the Vultee Vanguard 48 both in appearance and dimensions. Maybe we had our own Zero and didn't realize it.

Jim Halpin
Alexandria, Virginia

The Zero had a de Havilland fin, a Blackburn rudder, and a Bristol tailplane!

J.R.C. Young
Cumnor Hill, England

Mitsubishi took a Curtiss design and eliminated all of the armor protection.

Kent H. Meline
Vancouver, Washington

Editors' reply: Contemporary fighters all share a basic configuration, and some parts of the Zero were built under license. But the Japanese navy forced Horikoshi to start with a clean sheet of paper, and the intense interest in the Zero in the West is the strongest evidence that the fighter was an original work.

Farewell

What happened to the Anniversaries?

B.B. Oros
Reston, Virginia

Editors' reply: After a successful run of four years, the Anniversaries were discontinued before they were forced to repeat themselves.

The Navy Had Nose Art Too

A PB4Y at a Naval air station in Oahu, Hawaii, had a beautiful naked lady captioned "Open Bottom Baby" ("Risqué Business," April/May 1990). Spotting this art, an admiral inspecting the base refused to continue until the lady and caption were painted out. He said, "We can't have the enemy see us as a bunch of sex maniacs."

Samuel G. Burtis
Camden, Maine

A Fellow Groundling

For the last 30 years my husband has been a reluctant and increasingly tense frequent flier. Therefore, Edwards Park's amusing article on the Man Will Never Fly Memorial Society (Flights & Fancy, April/May 1990) really got our attention. However, it also left us with one question: how can we contact them?

Darlene Luckeroth
Portland, Oregon

The Man Will Never Fly Memorial Society can be reached at: Rural Route 1, Box 138, Nags Head, NC 27959.

Corrections

In "Higher Learning" (February/March 1990) you say that the National Test Pilot School "is the only civilian school in the world that specializes in transforming pilots and engineers into test pilots and test engineers." The International Test Pilots School at England's Cranfield Airfield has been operating successfully for about four years now, training pilots and engineers to the high standards required to graduate as test pilots and flight-test engineers. I am pleased to report that last year we were awarded the German LBA Class 1 test pilot approval, ranking us alongside the long-established military schools in LBA's eyes. The ITPS is indeed a force to be reckoned with and is playing a full part in the international flight-test arena.

K.P. Clarke
Training Director,
International Test Pilots School
Bedfordshire, England

In "Ticket to Ride and Ride and Ride . . ." (February/March 1990) the photograph of the Taj Mahal is incorrectly captioned. The "water buffalo team" is really a pair of oxen.

Robie I. Behera
Boston, Massachusetts

The flight of N740PA from Los Angeles to New York's JFK last February 14 did not set a speed record, as a caption in "Countdown" (April/May 1990) indicates. The record is still held by a 1963 flight of a Boeing 707.

Air & Space/Smithsonian *welcomes comments from readers. Letters must be signed and may be edited for publication. Address correspondence to* Air & Space/Smithsonian, *370 L'Enfant Promenade SW, 10th Floor, Washington, DC 20024.*

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"There'll Always be a (New) England" Dept.

RICHARD THOMPSON

"The crate has landed," Larry Ross declared happily one evening late last March when he arrived home in Canaan, Maine. Using a friend's trailer, he'd driven southwest to Contoocook, New Hampshire, and brought back the crate that protected Charles Lindbergh's *Spirit of St. Louis* during its westbound Atlantic crossing.

Ross had been intrigued by the big wooden box from the moment he first read about it in the *Waterville Sentinel*. "It's up for sale," he told his wife Rebecca. "I'm gonna go for this." Two months later and $3,000 poorer, he got it.

After Charles Lindbergh made his solo flight from New York to Paris in 1927, he'd planned to fly across Europe, Asia, the Bering Strait, Alaska, and Canada until he was back at Roosevelt Field on Long Island. But Secretary of War Dwight Davis complained that the trip would take too much time. Davis had planned a public ceremony to promote Captain Lindbergh to colonel in the Army Air Corps Reserve, and he didn't want to wait several months to do it. Politicians also demanded a share of the limelight, and big business eagerly sought the young pilot for product endorsements.

President Calvin Coolidge, prodded by the secretary of the Navy, finally sent the USS *Memphis* and Vice Admiral Guy Burrage, commander of the U.S. naval forces in Europe, after America's new hero and his airplane. Lindbergh, disgruntled that the *Spirit* would have to return home "in a coffin," nonetheless flew it to Gosport, England, where the Royal Air Force disassembled it, placed the fuselage in a pine box 29 feet long, 11 feet wide, and 10 feet high, and loaded the crate aboard the *Memphis*. The cruiser then headed to Cherbourg to fetch Lindbergh, who was hopscotching around France and England in a borrowed Royal Air Force aircraft.

When the *Memphis* arrived in Washington and the *Spirit* was uncrated at Bolling Field, Burrage asked Lindbergh for the crate as a souvenir. "He'd decided to take it up to Contoocook and turn it into a summer cottage," says Ross.

Five years ago a grandson sold the admiral's property, and this year the new owner decided he no longer wanted the ramshackle cottage on his land. It had windows and a door, and at one time even had electrical wiring and a phone, but in recent decades it had deteriorated.

"You come and look at it right now," says Ross, "and it doesn't look the greatest. But what it's *going* to look like will be pretty slick by the time I'm done. I've found a picture of how the admiral had it set up, looking very sharp, and I intend to redo it just like that."

Ross has also begun a memorabilia collection and wants to record oral histories of anyone associated with the flight, the pilot, the cruiser, or the crate. He's already found a veteran in Alabama who served aboard the *Memphis* in 1928. Now he's looking for someone who was on board for the crate's maiden voyage.

—Richard Sassaman

Update

NASA Data Storage "Deplorable"

The U.S. General Accounting Office has charged in a recent report that NASA's methods of storing magnetic tapes containing space science data "may result in the permanent loss of irreplaceable . . . data" ("NASA's Data Deluge," October/November 1989). Of the 10 NASA facilities the GAO inspected, eight did not meet federal guidelines on the care of magnetic tapes. Tapes were found stashed in hallways, basements, and dust-covered boxes, and the GAO said some facilities lacked even rudimentary access control. In a report prepared for the House Science, Space, and Technology Committee, the accounting office recommended that in light of the data flood NASA will receive from current and future missions, the agency should overhaul its data management system, improve facility conditions, conduct an inventory, and assess the scientific value of all stored data.

Après-launch

Last February 22, Arianespace, the European commercial space consortium, hosted a private party at which guests were invited to view the liftoff of flight 36, the eighth launch of an Ariane 4 rocket. Its payload consisted of two communications satellites owned by Japan: the Superbird-B and the BS-2X, stacked one atop the other in the slender nose fairing. The affair was held at the National Press Club in Washington, D.C., where a conference room had been fitted out with a bar and generous trays of hors d'oeuvres. By six the room was beginning to fill, and a large video screen facing several rows of chairs was projecting live pictures from the firm's launch site in Kourou, French Guiana. Cocktail chatter soon drowned out the sound from the TV.

At particularly important moments, Sune Abrahamson, an Arianespace mission manager acting as host in Washington, would interrupt the party talk on a public address system to remind those present, most of whom were engaging in Washington gossip, that some milestone in the count would soon be reached. When liftoff approached, he called for the guests' attention. *Trois, deux, un,* and at *zéro,* flame and smoke billowed from the pad and the Ariane V36 rose smoothly, tracked by the camera.

The rocket raced through some cloud layers seen only as fleeting glows in the engines' exhaust, and a new display appeared on the video image, showing the

Ariane's trajectory—a sort of half parabola—along which a small lighted oval marked the rocket's progress.

At one point the camera appeared to have been bumped and the image of the rocket was lost. Momentarily, a cloud of reddish gas appeared—perhaps the passage through another cloud layer?—but then the screen went dark and the video returned to focus on the face of launch director C. Berna, whose expression was utterly impassive. The voice narrative ceased, and in the room in Washington the conversation died. Still, the bright little oval continued along its track until it reached the rightmost limit of lateral travel, after which it rose like an ant that's encountered a wall.

Berna's eyes flitted right and left, and soon two engineers were seen huddling in conversation, like surgeons who've hit a snag during an operation. In the room in Washington, someone in the front row of chairs whispered about "a problem," and after a few minutes Frederic d'Allest, chairman of Arianespace, was seen holding a microphone. When d'Allest spoke in French, the word *"exploser"* caused a slight stir. When he repeated his announcement in English, the guests learned that flight 36 and its two satellites had been lost.

In Washington, a minute or so passed during which only murmurs of conversation could be heard, but then the party gradually built to its former roar, even if the smiles now seemed a bit frozen. What does one say at a launch party, after all, when the rocket blows up? Where is Miss Manners when you need her? Abrahamson interrupted once more to say there would be no further information until the next morning but the guests were welcome to stay as long as they wished. Nobody gave so much as a hint of moving toward either the disappointed hosts or the door, though the celebratory atmosphere was clearly dissipating. "Guess it's time for a condolence drink," said one guest, and as the event showed no sign of ending soon, the bar kept right on pouring.

The next day Arianespace released an account of what had happened: Engine D (a Viking V) in the first stage lost half its combustion chamber pressure at 6.2 seconds into the launch. Engines A and C swiveled 1.2 degrees to compensate for the lost thrust, but at about 90 seconds the engines had hit the maximum swivel and control was lost. The rocket broke apart

VIRGIN ATLANTIC

Update

Milestones in Nose Art

- World War II's airborne Varga Girls are resurfacing, this time on airliners ("Risqué Business," April/May 1990). Virgin Atlantic Airways chairman Richard Branson oversaw the adornment of five Boeing 747s with Vargas artwork. "Richard loves them," says spokeswoman Lori Levin. "He personally picked the model for each plane."
- Margaret Polk died of cancer in Memphis, Tennessee, on April 5 ("The Two Memphis Belles," April/May 1990). She was 68. The Carnival Memphis Airshow, held April 7-8, was dedicated to her memory.

and exploded at 101 seconds. An investigation later found that a small piece of cloth, perhaps left after cleaning, had clogged a water line in the first stage and caused a drop in fuel pressure.

The first Ariane rocket was launched in 1979, and various versions of the booster have placed a total of 43 satellites in orbit. Not including the two lost satellites, the firm has orders to launch 32 more. Arianespace postponed its black-tie anniversary gala in Paris until those launches restart.

—George C. Larson

Update

Space Station Reconsiderations

Citing a $350 million estimate to develop a high-pressure spacesuit that would reduce preparation time for spacewalks, NASA has cancelled its development in favor of beefing up the current shuttle suit ("The Blue Collar Spacesuit," October/November 1989). However, that decision is being questioned by critics who charge that exterior service and maintenance will play a considerably larger role in space station operation than initially envisioned.

In light of this increased maintenance, NASA has also come under fire for not giving automation and robotics development higher priority ("Invasion of the Spacebots," February/March 1990). A NASA advisory committee has charged that the agency has not yet defined the role the Flight Telerobotic Servicer will play in assembling and servicing the station and that "management is not encouraging the promotion of an appropriate number of A & R applications."

An Orbital Archive

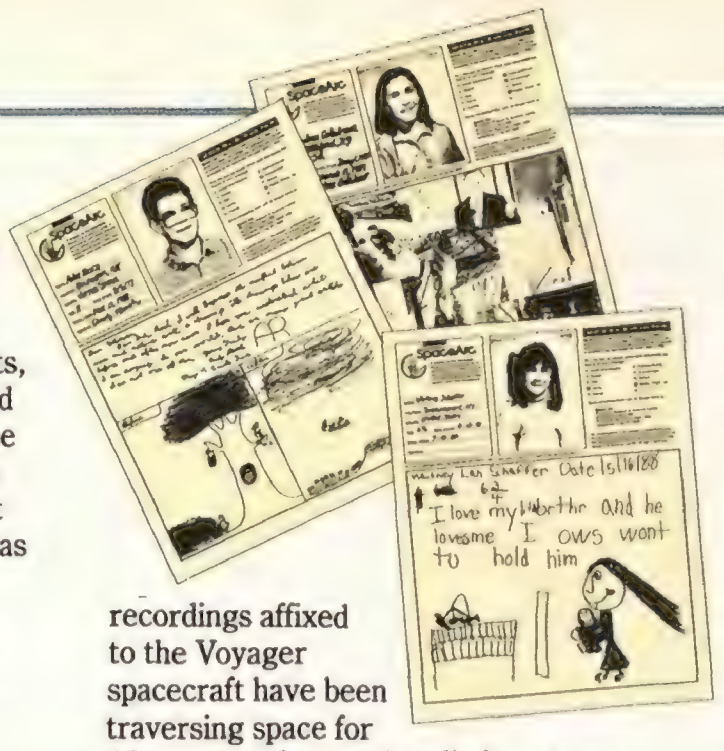
When Lou Gramm, lead singer of the rock group Foreigner, was approached by Jim Ferren during a flight to New York last year, he assumed it was just another autograph request. Ferren is a fan, but as project director at the Rochester Museum and Science Center, he targeted Gramm as

a potential musical contributor to his pet project.

Ferren's Space Arc project is an ambitious effort to document the thoughts, ideas, and wishes of the world's youth and preserve them on optical discs that will be put in an orbital archive. The idea, which began as Ferren's homework assignment for a 10th grade science class in 1973, was embraced by the Rochester museum in 1988 and recently won the backing of NASA's education division and the U.S. International Space Year Association.

The plan is to gather everything from one-page notes to songs and elaborate artwork currently being solicited in U.S. and Soviet classrooms and transfer the collection to optical discs along with an encyclopedia and dictionary. The discs and an imaging system will be placed in an archival container that will be piggybacked onto a 1992 payload to be launched to commemorate the International Space Year and the 500th anniversary of Columbus' journey.

Space Arc organizers admit that the likelihood of another life-form finding—and reading—the discs is pretty remote. (The



recordings affixed to the Voyager spacecraft have been traversing space for 13 years, and no one's called yet to say thanks.) Primarily, they see the project as a philosophical experiment that may prove more useful on Earth than in orbit.

"If you're going to do a true study of philosophy, then you have to ask all five billion of us," says Ferren. "One of the most practical ways to do that is to invite the world to get together and in essence write a book, whereby everyone would write their own page . . . whatever they want, whatever they care about." Contributors are asked to choose one of 10 headings in which to categorize their entries, such as Political/Social, Environment, Space, Family, or Goals and Dreams. (Another category could be Excuses for Not Having Your Homework—e.g., "It got launched into space.")

"Once you've completed this massive book," Ferren continues, "what are you going to do with it? It needs to be in a grand place, in a romantic place. Of course, that place is space."

True, but all the notes, photos, art, and music transferred to the Space Arc discs will also be stored on interactive information systems at various museums like the one in Rochester. "The idea is to go into a museum in the year 2049 and see what your thoughts were about life on Earth in 1990," Ferren says. "Better yet, you'll be able to share them with your grandchildren."

Gramm ultimately signed on as a member of the project's board of advisors. He's also composing a contribution. "I'm trying to absorb as much as I can of what these kids are putting out," he says. "I want to make sure it's majestic without being pompous."

—Bruce C. Pilato

Update

An Astronomical Letdown

Heartbroken astronomers announced last February that signals from the supposed pulsar created by Supernova 1987A ("Blast From the Past," August/September 1988) were actually spurious signals from the detecting instrument. Scientists had been puzzled by the object's unheard-of rotation rate of 2,000 times per second. Richard Muller of California's Lawrence Berkeley Laboratory said at the annual meeting of the American Association for the Advancement of Science that he felt "great disappointment and shock" but "I take some comfort in the fact we are the ones who found our own mistake."

The Fairfax Connection • February 8, 1990

Dulles Pans Film Script

Airport Authorities Enraged at Depiction in 'Die Hard' Sequel

By MARK PITSCH

THE CONNECTION

If 20th Century Fox could have its way, Washington Dulles International Airport would be renamed not for Dwight D. Eisenhower, but for John McClane.

McClane, as played by Bruce Willis, saves the airport from capture by terrorists in the movie "Die Hard II: Die Harder," scheduled for release this summer.

Not at This Airport, You Don't!

Any filmmaker planning an airport movie featuring terrorist hijinks, fuel-starved airliners unable to land because of sabotaged runway lights, and a hero played by Bruce Willis should take one bit of advice: Don't set the film at Washington-Dulles International Airport.

That's the setting of 20th-Century Fox's *Die Hard II: Die Harder.* And the

Metropolitan Washington Airport Authority, which administers the suburban Virginia facility, is not at all happy about the way the script depicts the airport and its personnel.

The movie, scheduled for a June release, is the sequel to 1988's *Die Hard.* In that smash hit, Bruce Willis played John McClane, an off-duty cop who oversaw the destruction of a high-rise office building as he foiled the plots of nasty terrorists. McClane's knack for being in the wrong place at the right time is undiminished in *Die Harder.* While waiting for a flight at Dulles he lands in the middle of a plot to free a captured drug-running Central American dictator. During the bulletfest that follows, the personnel at the celluloid Dulles apparently behave in a manner unbecoming their real-life counterparts.

"We object to them using the name Washington-Dulles Airport," says David Hess, a spokesman for the airport authority. "The movie depicts people at the airport as incompetent people. They have planes flying around, running out of gas, when you know that the planes would really go to an alternate airport."

But isn't it only a movie? "We still object to them using the name," says Hess. And it's not just the airport authority that's upset, he says: "It's the whole aviation community."

Well, perhaps not the *whole* aviation community. When the production crew went scouting for locations (Dulles had been ruled out because it was too far from Hollywood), it received a warm reception from Denver's Stapleton Airport.

"We knew they were going to film it somewhere," says Richard Boulware, Stapleton's deputy director of aviation. And since the production would spend up to $50,000 a day while on location, Stapleton didn't need much arm-twisting. "I personally read four revisions of the script," says Boulware. "Some of the airlines here were not terribly happy at first, but I think we allayed their fears."

Boulware won't comment directly on the reaction at Dulles, but he does say, "I think there was an overreaction by a lot of people who had not read the script. It's one gigantic comic book. It's so preposterous that any aviation professional who read the script would fall out of his chair laughing."

Nonetheless, Dulles airport's senior counsel, Edward Faggen, is negotiating with Fox to get a disclaimer placed prominently at the beginning or end of the film. Fox spokesman Dennis Petrosky says, "We intend to include a disclaimer in that movie that it is wholly fictional, which we typically do with many of our movies."

While the fur, feathers, and airplanes

flew, the *Die Hard II* technical crew moved on to Mojave Airport in California to finish some special effects shots. Dulles authorities won't be pleased to know that the technicians were busily crashing model airliners—no doubt the airliners that, in real life, would have been routed from Dulles to Washington National or Baltimore-Washington International.

—Tom Huntington

Update

Salyut 7 Heading for a Fall

The Soviet Salyut 7 space station, launched in 1982 and abandoned in 1986, will reenter Earth's atmosphere early next year ("The Rescue of Salyut 7," February/March 1990). Soviet officials had suggested that the Buran shuttle be used to retrieve the station, which had been boosted into a "mothball" orbit. But peak solar flare activity has dramatically increased atmospheric drag on spacecraft in low Earth orbit, and last spring Salyut 7's descent began to accelerate. The station will be the largest man-made satellite to fall to Earth since Skylab's fiery arrival in 1979.

DAVID CLARK

Smokers who are unhappy with the recent tobacco ban on all airline flights should consider getting an airline transport pilot's license. The government refused to extend the smoking ban to the cockpit, citing studies that show nicotine withdrawal can cause aggressive or irritable behavior and impair decision making. Rather than have aggressive and irritable pilots plying the airways, officials chose to let the airlines set their own cockpit policies. Currently some carriers restrict cockpit smoking; others leave it up to the crew.

Trickle-Down Technology

For years scientists have been using data from the Voyager probes to study Jupiter, Saturn, Uranus, and more recently, Neptune; soon the same wealth of planetary imagery will be made available to high school students.

NASA's National Space Science Data Center at Goddard Space Flight Center in Maryland is putting together a series of compact discs containing photos and data produced by Voyager, the Viking Mars probe, the International Cometary Explorer, and other deep-space missions. Ten discs have been prepared; by 1992, as many as 70 may be available, including data from missions like the Magellan Venus probe.

The discs will cost about $45 each. A compact disc reader—costing about $700—is needed to convert the data into a form digestible by a personal computer. That may seem pricey, but NSSDC director James Green says it's a lot cheaper than the $100,000 worth of equipment required to translate the information on a raw tape into usable form.

Green hopes high schools will buy the discs to spur student interest in space exploration. "When my kids go to high school," he says, "I'll insist that the school has compact disc readers."

Increasingly, NSSDC data has become available to the public through NASA databases. Requests for information were previously made by mail or phone, but now anyone with access to the Internet, BITNET, or Telenet computer network can call NSSDC computers around the clock. Callers can review a menu of services and data or search by keyword to locate information on climatology, astronomy, astrophysics, inner planetary particle and field data, or atmospheric and land science, and then download the data to their computers. This helps college students pulling all-night study sessions as well as scientists in Europe, Japan, and Australia.

Opening up the request lines has proved wildly popular. Last year the center received 8,000 requests via computer and 2,500 letters. Soviet space scientists, for example, asked for 900 photos of Mars to use in identifying possible landing sites for future Phobos missions.

Occasionally the requests are more bizarre. Some tabloids have asked for a photo that supposedly depicts a World War II bomber in a lunar crater. The "face on Mars" is another favorite. Green won't say much about the face, which some claim was made by ancient astronauts. However, he does agree that Mars has some notable features, including one "which looks like Kermit the Frog."

—Martin Morse Wooster

Update

Soviet Manned Spaceflight Crunch

The Soviet budget for manned spaceflights has been whittled down to 74 percent of last year's funding (Soundings, April/May 1990). Aleksandr Dunayev, director of the Glavkosmos space agency, says the organization will have to look elsewhere for funding. This year's launch manifest calls for only two more manned flights to the Mir space station.

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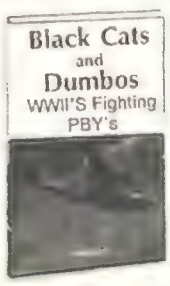

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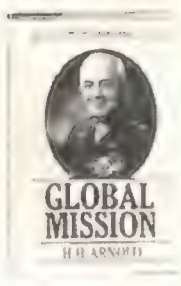

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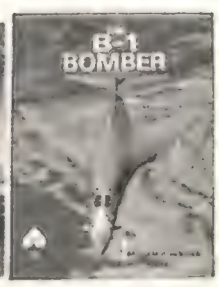

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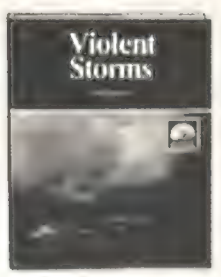

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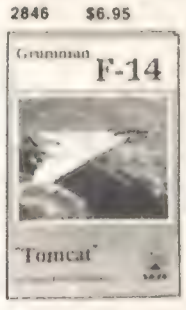

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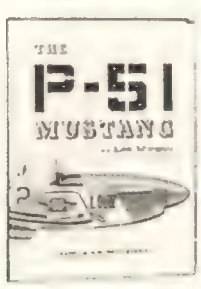

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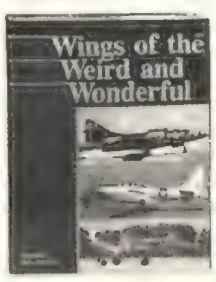

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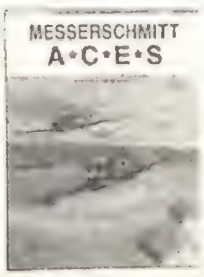

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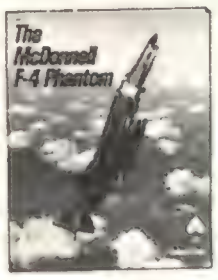

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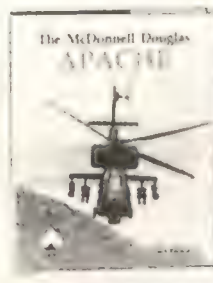

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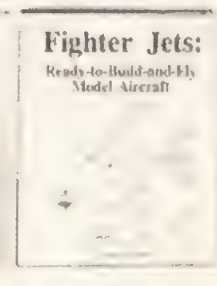

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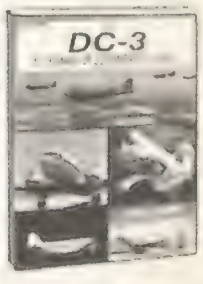

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Five for a Nickel

The other kids in the third grade thought I was weird. They collected baseball cards and dreamed of finding Mickey Mantle in their Topps bubble gum packs. My passions, however, ran more to the likes of the Douglas D-558-2 Skyrocket and the Avro 707A. I collected airplane cards, a short-lived phenomenon that appeared in the early 1940s and again in the '50s.

Old baseball cards are now hot items (a 1952 Mickey Mantle commands $6,000); old airplane cards, on the other hand, fetch only about a dollar apiece. But I still have mine, in the same cigar box I used 36 years ago, and if my house were burning down they'd be the first thing I'd try to save.

CARDS COURTESY DAVID NOLAND

The cards were produced as a sideline by Topps, the leading baseball card company. Unlike the two-per-pack airplane cards that had been put out by Wings cigarettes in the early 1940s, Topps' Wings cards came five to a pack, which cost a nickel. Thick three-by four-inch pieces of cardboard, they were much more substantial than today's flimsy baseball cards, and you got a sheet of brittle pink gum in the bargain.

The 1952 Wings series totaled 200 cards. The few airplane card aficionados in my school regularly held swap meets where we would flip over our "doubles"—duplicate cards available for trading—while the prospective swapper chanted "got it, got it, don't got it, got it, don't got it . . . ." The don't-got-its would then be exchanged on a one-for-one basis. Occasionally, complex deals were struck for singular cards. Harry Joe Scott was obsessed with transports, and I gleefully pawned off a couple of nondescript cargo airplanes on him in exchange for a North American F-86 Sabre, a Grumman F9F Panther, and a D.H. 112 Venom. It may have been the best deal I've ever made.

After a year's expenditure of nickels, plus canny trading with other airplane card buffs, I managed to collect the entire Wings set. I clearly recall the transcendent moment when I opened a pack to find the last card I needed—number 179, the DHC-1 Chipmunk trainer.

The early 1950s were fascinating years in aviation, an era of rapid progress that saw the proliferation of new and bizarre aircraft types. The Jet Age was in full flower, and dozens of jets emerged with such features as delta and variable-sweep wings, turbojet and turboprop hybrid powerplants, twin booms, twin fuselages, T-tails, and V-tails. And the artwork on the Wings cards reflected the excitement of those times. The artists, with prodigious imagination, jazzed up the backgrounds with spectacular sunsets, ominous cloud formations, and combat action galore. Blazing guns were everywhere, while burning enemy airplanes and flak bursts filled the skies around even non-combatants like the North American T-6 trainer and the Ryan Navion, a four-place lightplane.

Card 95, for example, shows a McDonnell F2H Banshee diving steeply through a blood-red sunset and a hail of flak over a palm-fringed lagoon, the sea churned by geysers from exploding bombs. In reality, of course, the Banshee never saw combat in a tropical area, and would have surely crashed had it ever dived so steeply at that altitude. But I didn't care—I craved action, and the Wings cards supplied plenty.

In the capsule descriptions on the back of the cards, exclamation points outnumbered the flak bursts on the front, and the most mundane facts were made to appear momentous. "Strangely enough, this plane is wider than it is high!" read the blurb on the Bell H-12 helicopter. Spellbound, we learned that "the nose of the Canberra is made so you can see right through it!" And watch out for that Chance-Vought F7U

Cutlass: "it has the firepower to really deliver a telling blow!"

In addition to the text and performance statistics, the back of each card had a three-view silhouette of a mystery airplane, with a challenge to "Name This Plane—Friend or Foe." We were instructed to see another card for the answer, an incentive to spend more nickels.

Sometimes the selection of aircraft puzzled me. Why the T.H.K.2, an obscure Turkish trainer with a plywood skin, but no

Bell X-1? Why the Argentinean I.Ae.27 Pulqúi fighter ("every inch a modern plane!") but no Boeing B-52? And sometimes the selectors got stuck in a rut—cards 154 to 164 were all helicopters, while another group numbered eight consecutive French jets. At other times they let their imaginations run amok: the airplane identified on card 120 as a MiG-19, sporting a banana-shaped tail that was longer than the fuselage ("This jet has a very weird appearance!"), bore no resemblance to any aircraft in existence.

But no matter—we nine-year-olds were highly susceptible to breathless prose and colorful art. Inspired by flak bursts and exclamation points, we waved the cards

about in sweeping arcs and supplied dogfight sounds—roaring engines, staccato bursts of gunfire, exploding fuel tanks, and a screaming death dive. For more sophisticated sound effects we used clothespins to clip the cards on our bicycle frames so they would flap in the whirling spokes. The resulting *brap-brap-brap-brap,* we believed, approximated a P-51 at full throttle, and we spent hours chasing each other down the street in noisy aerial combat.

A few years ago, while idly thumbing through a tattered 1951-52 edition of Jane's *All the World's Aircraft,* I was thunderstruck to see page after page of familiar aircraft in familiar poses. I pulled out my cards. In some cases the artist had changed a dull background into a dramatic inflight shot by retracting the landing gear and adding flak bursts or clouds, but otherwise the images on dozens of cards were identical to those in Jane's. Even the order in which the cards had been issued was copied. The Sud Ouest S.O. 6021 Espadon, the S.O. M.2, and the S.O. 6000 Triton—consecutive cards in that odd run of French jets—were on consecutive pages of Jane's. I called Topps, but no one there remembered what they had used for a source. Disillusioned, I could only conclude that the people who produced the Wings cards were not airplane nuts but instead baseball nuts on temporary duty.

Topps issued two more series of airplane

cards, Jets (1954) and Planes (1956). A few of us half-heartedly trafficked in Jets, but nobody I knew bothered with Planes. We were growing up, I guess, and television had begun to compete for the visual and aural imaginations of the nation's youngsters. What little piece of cardboard could compete with a 19-inch screen that supplied its own battle sounds?

More importantly, postwar aviation production was slowing by the late 1950s. The crop of new airplanes was getting smaller every year. Nowadays we see a new fighter or bomber type only once or twice a decade, and usually its most newsworthy feature is a cost overrun, a structural defect, or the accounting methods of its contractor. Moreover, performance increases have hit a brick wall. The Navy's latest fighter, the McDonnell Douglas F-18, is no faster than the Lockheed F-104, which first flew in 1954. No wonder airplane cards went out of style.

—David Noland

Hurricane Season

CAROLYN RUSSO

Dave Peterson still has years to go with the Hurricane restoration.

The good-luck charm found at the bottom of the Hawker Hurricane's grimy cockpit probably belonged to a young Royal Air Force pilot. Most likely he lost it as he learned how to fly the airplane in the waning days of World War II. The Battle of Britain had been won and this Hurricane would never see combat. It would spend the rest of the war training pilots.

It was during the dark days of 1940 when British pilots really needed their good-luck charms. As the RAF struggled against the Luftwaffe, England's salvation depended on its Hurricanes and Spitfires. Although the Spitfire has become the symbol of the battle, the Hurricanes actually did most of the fighting. While not as fast as the Spitfire or the Luftwaffe's Bf.109, the Hurricane had a reputation as a rugged workhorse with superior maneuverability. "We were better than the [Bf.109s] if they would stay and 'mix it,' " wrote Peter Townsend, RAF commander of 85 Squadron, in his book *Duel of Eagles.* "We could turn faster."

Today only a few dozen of the 14,231 Hurricanes built between 1937 and 1944 still exist. One of them is at the National Air and Space Museum's Paul E. Garber Facility, where it is currently being restored by project leader Dave Peterson. The tiny medallion he found is sealed in a plastic bag in a drawer of his worktable. The cockpit now sits on wood blocks. Old mattresses cushion the wings, their four 20-mm cannons aimed at file cabinets. Withered like an old snakeskin, the fabric of the airplane hangs over a board.

Peterson sits amid the dissected airplane at a workbench in Garber's Building 10. Fluorescent lights flicker and buzz high above in the corrugated metal ceiling. He has been working on the Hurricane for two years and this morning has just completed his work on the engine mount. In front of him sits the Rolls Royce-Merlin engine, covered with a sheet of plastic. "It's just so wonderfully artistic," says Peterson. "And the engineering behind it—there's more art in that than anything at the Hirshhorn [art museum] to me."

This model, the Mark IIC, was presented to the Museum in 1969 by British ambassador John Freeman on the 29th anniversary of the Battle of Britain. It was constructed in 1944. After serving as a trainer, the Hurricane was put on display outside the RAF recruit training center at Bridgenorth, Shropshire.

The long English winters took their toll, leaving the Hurricane severely corroded. "That's going to be a real nightmare," Peterson says, nodding toward the Hurricane's center section, which he plans to tackle next. Another headache has been dealing with the British method of securing nuts and bolts, known as staking. To secure the fastener, they hammered the end of each bolt to flatten it and keep the nut in place. Consequently, bolts sometimes have to be filed.

Peterson carefully documents all his work. On his worktable a notebook lays open beside a B-17 Flying Fortress coffee mug and a Far Side calendar. The notebook has a pencil sketch of the main landing gear's trunion and radius rod assembly. Two years ago he had the opportunity to compare notes with other Hurricane owners at a restoration seminar in Duxford, England. "All Brits except me," he says. "I was the Yank. They treated me great . . . . Talk about seventh heaven."

It will be at least three more years before Peterson completes his work on the Hurricane. For the time being he has no special plans for celebrating when he finishes. "The celebration," he says, "comes on a daily basis."

—David Savold

Dust Busters

Larry Johnson reaches over the railing, sweeps his hand down the side of the V-2 rocket, and examines his clean palm. "I didn't think they had gotten here yet," he says. This morning the V-2, which stands with the Jupiter-C, the Minuteman missile, and the other sentinels in the Museum's Space Hall, is not only one of the world's most historically important rockets, it is also one of the cleanest.

While most of the people who will visit the Museum today are still asleep, the priceless artifacts they will come to see are being cleaned by a squad of 12. To prepare for Johnson's self-styled white-glove test, the Museum's dust busters rely on cherry pickers and scissor lifts to reach the tips of

rockets and aircraft suspended from the ceiling as if in flight. "I tell every one of them, 'You have to treat this artifact as a child, as a baby,' " says Johnson, the foreman.

At this early hour the Museum resembles a cavernous beauty parlor, with each operator stationed at a historic air- or spacecraft and grooming it with a long-handled, fine-bristled radiator brush or a hot-pink feather duster. With a dustmop on a telescoping pole, Allen Lee stands in the basket of a cherry picker and rubs the belly of the first aircraft to fly four, five, and six times the speed of sound—the North American X-15. Estelle Washington, working in a lift and armed with a dustmop, brushes the tip of Robert Goddard's 1941 rocket. Norma Colbert, who was the first woman to drive one of the Museum's lifting machines, is working this morning with Delores Vanderhall in the Looking at Earth gallery, where a Lockheed U-2 hangs from the ceiling.

While the Museum's exhibits were once rugged flying machines, today they are precious artifacts. The operators use only Endust to clean—no detergents or scouring agents allowed. Special vacuums are used for early aircraft with delicate, fabric-covered wings, such as the Blériot monoplane and the Wright Flyer. "They take very good care," Johnson says. "My crew does a hell of a job."

Of course not all the dusting requires aerial acrobatics. On terra firma Marie Washington tickles the innards of a rocket with a feather duster. Roberto Pulos and Adell Lee are in the World War I gallery attending to the ground-bound SPAD XIII.

In addition to their regular rounds, the dust busters also assist with deliveries, help install smoke detectors, and tear down galleries to make room for new exhibits. But when fingerprints are all over Skylab and a special event has been scheduled for Space Hall, who you gonna call?

—Linda Shiner

Artifacts

CAROLYN RUSSO

On March 6 the National Air and Space Museum's latest acquisition announced its arrival at its new home with a sonic boom. The SR-71 Blackbird had departed from Los Angeles that morning and arrived at Washington-Dulles International Airport a record-setting 68 minutes later. Along the way it set three other speed records. Of course, this is nothing new for the Mach 3 airplane: 25 years after it was built it remains the fastest and highest flying U.S. aircraft. The SR-71 will be put on permanent display at Dulles once the Museum's planned extension is completed.

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

June 2 Monthly Sky Lecture: "Space, Time, and Gravity: The Fabric of the Universe." Jeff Goldstein, NASM. Einstein Planetarium, 9:30 a.m.

June 7 Legacy of Strategic Bombing Lecture: "From Pearl Harbor to Tokyo Bay." General Curtis E. LeMay, former commander of the U.S. 20th Air Force. Langley Theater, 7:30 p.m.

June 21 Exploring Space Lecture: "The Center of Our Galaxy." K.Y. Lo, University of Illinois, Urbana-Champaign. Einstein Planetarium, 7:30 p.m.

July 7 Monthly Sky Lecture: To be announced. Richard Schmidt, U.S. Naval Observatory. Einstein Planetarium, 9:30 a.m.

July 11 Resident Associate Program Film: *The Flight of the Navigator* (1981). Langley Theater, 8 p.m. Tickets: $6 members, $7.50 non-members.

Planning a Smithsonian Visit?
The Associates' Planning Packet is yours for the asking. Send a postcard to Associates' Reception Center, Smithsonian Institution, Washington, DC 20560, or call (202) 357-2700. Hearing-impaired visitors can use TDD and call (202) 357-1729. Begin your visit at the Associates' Reception Desk, located in the Smithsonian Castle.

Museum Hours Throughout the summer, most Smithsonian museums will be open 10 a.m. to 5:30 p.m. daily. The Smithsonian Castle, which has reopened with the new Smithsonian Information Center and Associates' Lounge, is open 9 a.m. to 5:30 p.m. daily.

Before the day's visitors arrive, Estelle Washington dusts off the Wright Flyer.

CAROLINE SHEEN

Looking for *Langley*

We were lost. The weather was bad, our fuel was low, and nobody could contact our aircraft carrier, the USS *Langley.*

Our scout squadron of Vought O2U-3 Corsair biplanes had launched from a pitching flight deck into a hard rain before dawn that morning of November 15, 1933. Poor visibility had quickly forced us into a tight formation and kept us in it, hampering our training raid against a target near Point Arguello, California. All I wanted now was to find *Langley,* land, and sleep. It was only 8 a.m.—and my birthday as well—but as far as I was concerned the day was shot.

It sure started badly. I had overslept and almost missed the preflight briefing. When I saw the clock I realized I had only seconds to dash to the ready room. If I'd taken time to put on my uniform I'd have been late and in trouble all day with the squadron commander. So I pulled my fur-lined flight suit over my new red silk pajamas (a birthday gift from my mother-in-law) and ran to the meeting.

We left *Langley* at about 4:30 a.m. Now, four hours later, we circled above our rendezvous point in the Pacific. But *Langley* wasn't there.

The leader of the squadron, Lieutenant Commander William Updegraff, decided to keep flying on our original heading. Back then, the Navy's direction finding equipment was primitive and sometimes unreliable, but we hoped we would find the carrier waiting further out. After a while, though, I began to worry. Big waves were forming on the ocean. If we flew till we exhausted our fuel, we'd have to ditch in that sea, an especially difficult and dangerous landing.

Updegraff pulled up alongside my aircraft. Using arm and hand signals, he told me he was out of fuel and was going to ditch, and that I—a fairly new lieutenant junior-grade—was now squadron commander.

I watched him leave the formation and head below. I knew that unless *Langley* appeared shortly, all of us would eventually have to follow him. I immediately sent *Langley* a distress call, praying somebody would hear it. Then I turned around and headed east, the rest of the squadron following. None of us had enough fuel to reach the coast, but the closer we got to land, the greater our chances of surviving.

* * *

Long before that day I had learned that flying was dangerous. My father, an engineer, had worked with Glenn Curtiss, and I'd known pilots, Navy and civilian, since boyhood. Many had been seriously injured and even killed in flying accidents. But I was fascinated by aviation. I can still recall clearly the first time I saw an airplane in flight. I was only seven years old, but the excitement I felt then remains with me even today.

Maybe the danger even whetted my appetite. But the lure of a risky job wasn't the only reason I wanted to be a Navy pilot. In 1926 I was a high school dropout and an enlisted man when I got my appointment to the U.S. Naval Academy in Annapolis,

A wooden flight deck transformed an ordinary collier into the Langley, *the Navy's first aircraft carrier.*

NAVAL AVIATION HISTORY (2)

Maryland. In those days, serving as an enlisted man made it more difficult to get ahead as an officer, even if you had an academy education. Aviation was a way around the problem; it was a growing technical field, one in which skill counted more than pedigree. I believed my past would be less of an obstacle in an airplane than on a battleship.

By the time I reported to the Scouting 1 (VS-1) squadron aboard *Langley* in November 1932, I had spent seven years in the Navy, including a year of flight training in Pensacola, Florida. The instruction was first rate, and it was hard. Of the 67 men who started in my class, only 17 graduated. Unlike today, pre-World War II naval aviators were considered generalists, and we flew every type of military aircraft, from seaplanes to fighters. Our classes covered aerodynamics, engines, ordnance, and communications. We took airplanes apart; we put them together.

I was glad to finish Pensacola and ecstatic when the Navy ordered me to report to *Langley*. In 43 years of service I sailed aboard many ships, but *Langley* was always my favorite, even though she was neither beautiful nor powerful nor imposing. Until 1919 she'd been a collier; then engineers installed a wooden flight deck atop her. The alterations, completed in 1922, gave her a clumsy look and won her the nickname "Covered Wagon." But she was the United States' first aircraft carrier, making her the lab where we tested flying techniques and tactics that were later used extensively in World War II.

By the time I got to *Langley* she was no longer our only carrier. The *Lexington* and *Saratoga* were in service too, and compared with those vessels, *Langley* was small, with a flight deck only 534 feet long and 64 feet wide. When I came aboard, she carried only 30 aircraft—18 fighters and 12 scout bombers.

Whatever her aesthetic shortcomings, *Langley* was a happy ship and a great place to come of age as a naval aviator. Her small size offered both advantages and disadvantages. The quarters were cramped—in fact, the ensigns lived in a converted pigeon coop, once a necessity in the days before radio when pilots sent reports to the ship via carrier pigeons. The wardroom, however, was as cheerful as any I ever entered because all the officers knew one another. The old hands gave a warm welcome to the newcomers, something that didn't always happen on the larger ships. Poker and bridge were especially popular pastimes, though I avoided gambling. My family was growing and the Depression was well under way, so I couldn't afford to risk a cent. Once we paid the rent and utilities, cash was so scarce that my family often dined on "Coronado Quail"—hotdogs wrapped in bacon.

O2U Corsairs gave naval aviators aboard the Langley *a chance to get their feet wet.*

Aboard *Langley* we talked mostly about flying, of course: airplanes, equipment, tactics, and how aircraft carriers, not battleships, would define sea power in the next war. Our opinions—as both junior officers and fliers—didn't count for much in the 1930s Navy. The battleship believers ran the show, and airplanes, in their minds, had little offensive power. Our role was merely to find the enemy's ships and direct the big guns that would sink them.

But we did more than talk. We spent many hours in the air: flying on instruments, dive-bombing, and practicing dogfights. And we logged many hours in offensive training missions, including the one we flew on that stormy November morning when we couldn't find *Langley*.

* * *

Before Updegraff waved farewell and left me in charge, I had never held responsibility for anything beyond my own airplane. Taking over the squadron in these conditions during peacetime was something I'd never considered. But I did as I was told, trying to keep everybody together as we turned toward the coast.

Within a few minutes of Updegraff's departure, my fuel tank was nearly dry. I'd been studying the waves long enough to know that I wanted all the control I could get when I ditched, so I decided to land while I still had power. My radioman and I headed down. We hit the water with a tremendous splash. Our airplane started sinking immediately.

We quickly clambered out. Luckily my radioman had remembered to grab the inflatable life raft. I figured we'd be all right once we got in it. Unfortunately, when he inflated it the wind caught the tiny boat, wrenched it from his grasp, and sent it scuttering across the waves.

We had lifejackets, and thanks to several years on the Academy's water polo team I was a good swimmer. But when I saw the raft spin out of sight, I was sure we were going to die.

Our flight suits soon became waterlogged, so we discarded them. The lifejackets would keep us floating, but the situation looked hopeless. The wind was blowing strongly, rain continued to pour, and the swells were huge.

To this day I don't know how long we were in the water, but it seemed forever. Finally the USS *Cincinnati* sailed into view and spotted us. She launched a whale boat that pulled us from the water and brought us to the cruiser.

The captain was a tough line officer with little regard for the renegades in naval aviation. "Damned aviators," he said, giving me a slow once-over as I came over the side. "Who else would go swimming in the middle of the Pacific in red pajamas?"

Amazingly enough, rescue ships saved every member of the squadron. The Navy's investigation discovered that *Langley* had changed course away from the rendezvous point without telling us. In addition, the sailor who ran the ship's direction finding equipment had been sent to fetch some gear just when we had called for help.

Navy boards are usually thorough and pitiless, and the one that looked into this incident was no exception. The fliers were cleared; the captain took the blame.

Some good did come of all this. The Navy began requiring that ship captains keep direction finding equipment continuously manned during aerial operations and emphasized anew flight navigation training in the fleet and at Pensacola. As for me, I gained a new respect for navigators and squadron commanders. But most of all, I learned never to go flying in red silk pajamas.

—Vice Admiral John T. Hayward
U.S. Navy (Ret.)

Footnote

On Saturday morning, February 1, 1958, the *Washington Post* and papers worldwide reported under banner headlines that President Eisenhower had released the following statement:

"Dr. J. Wallace Joyce, head of the International Geophysical Year office of the National Science Foundation, has just informed me that the United States has successfully placed a scientific earth satellite in orbit around the earth."

But the report was wrong. Joyce had not informed the president. I had.

One perk of government service is the remote possibility of playing a role in history. For a few hours in early 1958, it looked like I might play at least a tiny one. But my ego trip resembled that of a satellite which fails to reach orbit: a spectacular rise followed by rapid descent and incineration.

As special assistant to Alan Waterman, director of the National Science Foundation, I was intimately involved in the International Geophysical Year and the satellite project that grew out of it. After the Soviets launched Sputnik, the Vanguard satellite program was rushed forward. When the Vanguard TV-3 exploded on the launch pad on December 6, 1957, its understudy, the Army's Jupiter-C, was given the go-ahead.

Arrangements for announcing our first satellite in orbit had been carefully prepared. Since the IGY was a civilian program, Waterman would be the one to inform Eisenhower if it achieved orbit.

The chain of communications was fairly straightforward. Joyce went to the Pentagon whenever a launch was planned. If a countdown began he'd call Waterman and me, and I'd call Brigadier General Andrew Goodpaster Jr., Eisenhower's staff secretary. If the launch was cancelled, as it had been on January 29 and 30, I'd call Goodpaster and we'd all relax.

On Friday afternoon, January 31, Waterman had to leave town. "You take my place," he said, "and call the president if the thing goes into orbit."

Then Joyce called. Tired of going to the Pentagon every night, he asked if he could arrange for the Pentagon to call him at home so he could keep me informed from there. I agreed.

Joyce called at 9 p.m.—the countdown was progressing. At 10:49 he called again. "It's launched."

"You should get over to the Pentagon," I said, my pulse racing. "It'll be a while before orbit can be determined and I want to get the report from you on the spot."

"But I haven't made arrangements to get through Pentagon security tonight," he

protested. "I might not get in." That took care of my on-the-spot report. "You better stay home after all," I sighed. Then I called Goodpaster, who told me to call back if the satellite achieved orbit. "I've reserved a White House line for you and a line to Augusta, where the president is spending the weekend," he said.

I hung up and thought about this for a minute, then told my wife, "This is starting to worry me. The call has to go from the Pentagon to Joyce at home to me at home to the White House and then to Georgia." Joyce's extra link in the chain of communication was raising the odds of something going amiss.

At 12:43 my phone rang again. "Explorer is in orbit," Joyce said excitedly. "Are you sure?" I asked. Yes, he was sure. I called the White House and told Goodpaster.

Pouring a stiff drink, I sat back to relish my tiny but enduring niche in history. *I'll be on the front page of every paper,* I thought. *I'll hear from friends I haven't seen since kindergarten.* Then it dawned on me that all hell would break loose at the National Science Foundation in a few hours and there would be no one there on a Saturday morning to field the flood of calls.

After catching a few hours of sleep I headed to the office, where I saw a copy of the *Post* and its announcement that Joyce had been the one to inform Eisenhower about Explorer. Probably the press release had been written at the Pentagon, and because Joyce had arranged to be called at home, it was assumed that he would pass the word to Eisenhower.

I realized what the press might do with the idea that the president did not even know just who had given him such momentous news. As a dedicated Republican, my only solution was to pretend that Joyce had indeed informed Eisenhower. I immediately called Joyce and asked him to come downtown. "And please don't answer your phone in the meantime," I added.

Then the producer of "Meet the Press" called. "We have Senator Dirksen on the show tomorrow," he said, "but I'm sure he'd give up five minutes so our audience can hear from the man who informed the president that our first satellite was in orbit." I agreed wholeheartedly that such a man deserved a nationwide audience.

In the meantime my wife had gone to a large wedding, where she proudly told the guests—including friends in the press—about my late-night calls. That evening we were to dine at columnist Rowland Evans' house with several of the wedding guests. "If anyone asks why I wasn't mentioned in the papers," I told my wife, "just say you misunderstood precisely who I called and when."

During cocktail hour, the difference between my wife's earlier account and the papers' was brought up. "I thought *you* were the one who called Ike," a reporter said. "I was in the, uh, the chain of communication," I said, "but Joyce actually informed the president." Thus I was forced to assume the familiar role of the Washington official who exaggerates to his spouse the importance of what he does. For me, it was a long evening.

My place in history is forever lost. But I do want it known at last that I rarely exaggerate the significance of what I do—at least I didn't on that early Saturday morning 32 years ago.

—Neil Carothers III

THE PLANE THAT CONQUERED THE SKIES.

Precision-engineered model of Shoo Shoo Baby is shown smaller than actual size of 9⅛" in length. Wingspan of 12⅜". Scale 1:96.

SHOO SHOO BABY

B-17G "FLYING FORTRESS"

The B-17 "Flying Fortress." It was the very backbone of the Allied aerial offensive during World War II. Now, to commemorate the 50th anniversary of World War II, the Air Force Museum Foundation authorizes the authentic re-creation of a rare surviving B-17G that actually saw combat. It's called Shoo Shoo Baby, now on permanent display at the U.S. Air Force Museum.

Here is a remarkable die-cast model of the original, precision engineered of 111 components with a vast array of operating features. The propellers actually spin. The landing gear is retractable. The bomb bay doors open and close.

Shoo Shoo Baby also has astonishing detail. With a removable canopy that reveals the interior of the plane. Even the nose art re-creates the original's.

The price, just $195. A custom-designed display stand is included at no additional charge. Available only from Franklin Mint Precision Models.

This aircraft was designed and engineered from the actual B-17G "Flying Fortress," nicknamed Shoo Shoo Baby. It has not been authorized or endorsed by any branch of the United States Military or its manufacturer.

On the 50th Anniversary of World War II, the Air Force Museum Foundation Presents Its First Official Die-Cast Re-creation of the B-17G "Flying Fortress."

Shoo Shoo Baby can be removed from its handsome display stand.

Even the nose art captures the authentic look of the original.

PLEASE MAIL BY JULY 31, 1990.

Franklin Mint Precision Models
Franklin Center, Pennsylvania 19091

Yes! I want to order the authorized die-cast reproduction of Shoo Shoo Baby, a rare surviving B-17G that actually saw combat during WW II. My imported model will arrive with its own display stand at no additional cost.

I need send no money now. I will be billed for a deposit of $39.* when my model is ready to be sent to me and, after shipment, for the balance in four equal monthly installments of $39.*

**Plus my state sales tax and a total of $3. for shipping and handling.*

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ALL ORDERS ARE SUBJECT TO ACCEPTANCE

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12545-3

Franklin Mint Precision Models. Simply Miles Ahead.

With some numbers here, a beep or two there, and a good dose of common sense, the Kettering Group gains insight into the Soviet space program.

Satellite Sleuths

by Doug Stewart

Photographs by Patrick Ward

On January 24, 1978, a Soviet surveillance satellite containing a small nuclear reactor plummeted to Earth, spewing radioactive debris over the icy tundra of northern Canada. The crash of Cosmos 954 took much of the world by surprise. Even the computer-equipped trackers at the North American Aerospace Defense Command in Colorado didn't learn of the satellite's impending demise until November, and their initial projections put reentry in April.

One person, though, was not the slightest bit surprised by Cosmos 954: Geoffrey Perry, a physics teacher in the English industrial town of Kettering. In November one of Perry's 12-year-old pupils at the Kettering Boys School had noticed that the satellite's orbit was decaying, or losing altitude because of atmospheric drag. With help from Perry, the boy later calculated to within 24 hours when Cosmos 954 would make its fiery curtain call.

Perry is no ordinary physics teacher. He is the guiding force of the Kettering Group, an informal network of people who monitor the Soviet space program. Originally composed largely of Perry's young students, the group today is an assortment of adults of various nationalities. Most of the 20-some active members live in southern England, but others do their tracking from homes in Sweden, South Africa, New Zealand, and elsewhere. (There is a lone tracker in the continental United States, near Houston. Unfortunately for the Yanks, the farther you live from Moscow, the worse the listening.)

The group is strictly amateur: the members use table-top radio equipment, often second-hand, and credit intelligence coups like the Cosmos 954 prediction to patient observation and "doing sums." Despite the low-rent approach to space science, the Kettering Group is the Western world's most authoritative source of public information about the Soviet space program. Only intelligence agencies and the mili-

From his home near England's Cornwall coast, Geoffrey Perry works to ferret out Soviet space secrets.

tary know more. Kettering members are routinely the first to announce the launch of a Soviet satellite and the nature of its mission, or the failure of an attempted docking. Explaining why the group is interested in the Soviet space program, one member says simply, "It's the things that are secret that get our curiosity up."

The Kettering Group has no dues, no newsletter, not even an official membership list. "People write to Geoff and say 'I want to join,' but there's not really any club to join," says longtime member Max White. In fact, the bulk of the membership has assembled only once, when Perry accepted an award for the group from the Royal Aero Club in 1984. Quick, business-like phone calls and memos routed according to one's special interest are the group's currency.

While the Kettering Group may have a nebulous organization, Perry is clearly the leader. He finds enthusiastic and reliable people with special skills or knowledge, then brings them into the fold. Once part of the network, a member's status is best measured by how often he hears from Perry.

Now in his 60s and retired from teaching, Perry lives with his wife Jean in a secluded cottage on the rugged north coast of Cornwall. He is a stocky, gap-toothed man with a jutting chin, a fringe of white hair, and heavy horn-rimmed glasses. His speech is confident and emphatic. When Perry speaks of satellites he punctuates his talk with imitations of beeps, buzzes, and Doppler shifts. He makes absolutely no small talk, nor does he indulge in false modesty. He's openly proud of his awards, his honorary degrees, and his appointment as a Member of the British Empire, though he's not vain about it. He seems to view the Kettering Group's achievements, and his own, as triumphs of common sense, patience, and the amateur ethic—a victory for schoolteachers and schoolchildren everywhere.

Perry's leadership role in the group stems from both his dedication and his ability to make ingenious deductions. During the 1967 Arab-Israeli war, he determined that the battle for Syria's Golan Heights had ended two days before the Israelis announced it had. He had noticed that Soviet spy satellites were no longer orbiting regularly over the Heights. Now they passed almost directly over Cairo and the Suez Canal, which turned out to be the Israeli army's new front line. "The only difference between this and a crossword puzzle is that the Russians don't publish the answer the next day," Perry says.

At the Kettering School in the early 1960s, Perry had encouraged his students to study satellite orbits as a way to learn physics. "Gradually, we found that we could get into the intelligence game," he says. Perry and his young charges knew, for example, that telemetry signals from Soyuz missions consisted of 15 beeps of varying lengths, and that in mission after mission the eighth beep would be either short, medium, or long. Obviously, says Perry, it

Since retiring from teaching, Perry has more time to pursue space sleuthing.

was counting something—something that came in ones, twos, or threes. "I said to the lads, 'What is there about Soyuz that has got three?' and they said straightaway, 'Three cosmonauts!' " Their proof came when Soyuz 5 (with three cosmonauts) docked with Soyuz 4 (with one). The next day, Soyuz 4's short eighth beep had grown long, while Soyuz 5's long eighth beep had become shorter. The two spacecraft had swapped crews. "The Soviets announced the swap later that night," says Perry, still delighted.

Perry is proudest of his 1966 discovery of the Soviets' third launch site. He had been monitoring satellites that he knew couldn't have come from either of the known launch centers. A spacecraft must abide by the rules of orbital physics, Perry points out, and one is that the plane of an orbit must pass through the launch site. "One launch was at 70 degrees through here," he says, picking up a small tin globe to demonstrate, "and another at 65 degrees here. I traced the two back, and the point where they crossed was a spot 200 miles south of Archangel." This turned out to be a new top-secret space center at Plesetsk. When word of the discovery got out, the press descended on Kettering. "They got me out of the bath," Perry says. "When I went to get my hair cut, they got me out of the barber's chair."

Each member of the Kettering Group has a subspecialty. Les Currington taps into the imagery beamed down from satellites. "If it's sending a picture, I'll try to produce it," he says. A courteous, portly 72-year-old with the English passion for flower gardening, Currington doesn't look like anyone's image of a space scientist, let alone a crack intelligence operative. In fact, he's a retired TV and radio dealer. Yet many Soviet satellite photos published in the West were actually received, processed, and printed by Currington on homemade equipment.

Currington keeps tabs on a half-dozen or more weather satellites from his antenna-covered home in Hertfordshire. His workroom there is jammed with radio gear, much of it linked together with profusions of heavy black cable. Early each morning, using publicly available orbital data, Currington prints out a list of those satellites that will pass overhead in the next 24 hours. (Satellite signals are line-of-sight: you can't receive them until the satellites appear over the horizon.)

This morning Currington is studying his printout through a magnifying glass. At the moment Soviet weather satellite Meteor 2-16 is directly over the Alps and heading toward Scandinavia. It should be just in range. Currington fiddles with one of his radios, and in a few seconds a pulsing whistle pierces the static. On a small TV screen plugged into the radio, a black-and-white picture begins to appear from the bottom up, line by line. The camera inside Meteor 2-16 is producing a picture of Europe, and an onboard radio transmitter is me-

thodically beaming it Earthward. The fluctuating whistle is the audio equivalent of the changing pattern of lights and darks in each line on the TV screen.

"There's the heel of Italy," Currington says after a few inches have filled in along the bottom of the screen. A storm churns over the Mediterranean. "There are the Alps popping through the clouds there," Currington says. Should he get anything particularly interesting, he would make a crisp eight-by-ten glossy of the scene on a home-made photographic printer. The imagery that he treasures most is that from Soviet radar satellites, which can take pictures at night and see through clouds.

When tending to the bougainvillea

Kettering member Les Currington lives in Hertfordshire, where he divides his time between gardening and keeping tabs on Soviet weather satellites. Using a combination of homemade and store-bought equipment, he intercepts and prints out Soviet weather satellite images, such as this one from Meteor 2-16.

Dave Hawkins specializes in satellites called two-tones for their distinctive transmissions.

and begonias in his garden, Currington likes to leave the window of his workroom open and turn up the volume of a radio tuned to a promising frequency. He was out gardening when he picked up his first Chinese satellite, in fact. Every satellite has a characteristic pattern of beeps, whines, or whistles, he says, and just as the parents of eight children recognize the unfamiliar voice of a ninth, so the ears of a Kettering tracker perk up when a brand new satellite flies overhead. "If I hear an unusual sound," says Currington, "I'll come in and record it. Then if I can't identify it, I'll phone Geoff Perry, and he'll identify it."

Dave Hawkins, a Kettering Group neighbor of Currington's, is hunched intently over the shortwave receiver in his radio room, busy hunting his speciality—an elusive breed of spy satellite known as a two-tone. "The bugger switched off this pass," he says grimly. "Lovely."

Hawkins is a tanned, muscular man in his 40s who's playing hooky today from his job as a printer's ink chemist. He's as ebullient and intense as Les Currington is reserved. As he scans through the UHF radio band, hoping the two-tone will signal again before it dips below the horizon, Hawkins describes his quarry. Two-tones are impromptu affairs, sent aloft on spur-of-the-moment reconnaissance missions that usually last only two weeks. The satellites' telltale signature is an alternating two-toned radio signal that lets Soviet ground control check their orbits, but it is broadcast only when a two-tone is in range of Plesetsk. The rest of the time the satellites maintain a discreet silence. At the end of a mission a reusable capsule containing the spy camera and film breaks free and parachutes down to Earth. "If you're lucky you'll pick up the radio beacon that lets the helicopters find it," Hawkins says. He's got tapes of this sort of thing. He can even discern from the sound how fast the capsule is revolving on its parachute lines.

Suddenly, a slow *whoop-whip-whoop-whip* fills the cramped room. "There's your two-tone," Hawkins says triumphantly as he snaps on his tape recorder. The siren-like whine almost drowns out conversation. "It's beautiful!" he shouts over the din. "You don't pick up two-tones like that except once a year!" He grabs a stopwatch and begins an intent count of the cycles. Only when he's finished does he lean back in his chair and breathe normally. "That's Cosmos 2036 all right," he says. It must have been maneuvering in orbit, he explains, because it's 10 minutes late. "I've been following it almost every day. This is day 13, and it's coming down tomorrow. I'm just working out the time so I'll know when I've got to get up in the morning."

When he's not listening in on the Soviet space program Hawkins likes to eavesdrop on the chatter of Royal Air Force fighter pilots. His bookshelves are filled with volumes like *Jet Combat* and *Fast Jets 2,* and one wall is dominated by a large framed poster of an F-5E fighter.

Before he started tracking satellites by radio, Hawkins simply watched them. With an accurate stopwatch and a detailed knowledge of how to use stars as reference points, he says, a visual observer can calculate a satellite's exact orbit after several sightings. Hawkins always brings a lightweight deck chair with armrests when he's on vacation. "On the beach at night, I'll just sit back with my binoculars and see if any strays come across," he says.

Like Perry, Hawkins has chalked up some successful sleuthing. Not long ago his radio picked up the launch of a Soviet spy satellite at an unaccustomed hour. The previous morning, he knew, a large amphibious NATO task force had left Plymouth for the North Sea. Working out the orbits, he concluded that the two-tone would pass directly over the battle group twice when the sunlight was best for detailed picture-taking. Like his fellow Ketterings, Hawkins keeps such deductions largely to himself, sharing them only with Geoff Perry and others in the group who might be interested. Publicizing one's cleverness is not part of the Kettering ethic.

Until he moved to a town near Gloucester this spring, Max White kept his satellite monitoring station in a shallow alcove off the dining room in his modest East Sussex home. Upon entering the house, White would routinely

Radio equipment is not necessary for no-frills observations; Hawkins also enjoys simple visual tracking.

turn into the dining room to switch on a radio before walking back to the kitchen to kiss his wife.

Thin and bespectacled with receding blond hair, White is fast-talking, opinionated, and quick to laugh. He also has a penchant for cigars despite his youth (asked his age, he replies, "I was born three days after Yuri Gagarin went up—that makes me 28"). Until it was shut down this spring, White operated a satellite-tracking camera at the Royal Greenwich Observatory, a job that gave him ready access to copious streams of orbital data. But he did most of his radio tracking on his own time.

White readily acknowledges he's an eccentric. "Some people go mad about football," he says, flicking cigar ash into a wastebasket. "We're just a little bit different." Tonight he expects to stay

up into the wee hours: the Soviets have announced a manned launch, and White will listen in on the cosmonauts during their critical early orbits. The Soyuz-TM 8 craft will dock two days later with the Mir space station, which has been empty for five months.

White admits that satellite trackers have much in common with birdwatchers—both endure long periods of boredom to collect occasional information of little interest to most people. But unlike birdwatching, satellite tracking is as much problem-solving as it is observation. "You ask yourself: Why is this satellite maneuvering now? What is its mission? Why did it transmit just then?" explains White. "To me it's like a jigsaw puzzle."

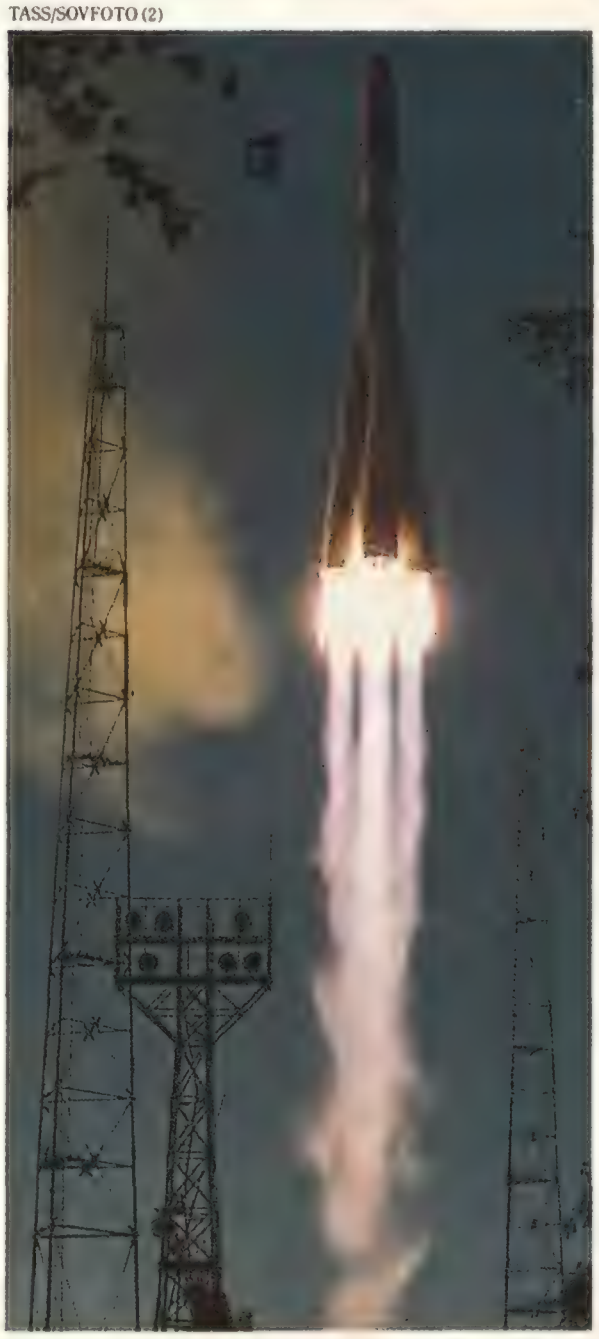
Just before dinner White swings by the public library to indulge in his own subspecialty. He grabs a week's back issues of a daily maritime newspaper, spreads them out on a table, and begins scanning page after page of fine print headlined "Shipping Movements." "I call these the heartbeat of the Soviet space program," White says as he jots down the name of a Soviet "research vessel" that was reported out of Istanbul last week.

For the Soviet Union to keep in radio contact with its cosmonauts at all times, it must deploy tracking ships off strategic spots like Montevideo, Gibraltar, and Nova Scotia. "During a mission, the boats just sit there like a telephone exchange," White says. A few years ago he realized he could trace the movements of nearly the whole Soviet tracking fleet by carefully perusing the published shipping reports. Now he does so weekly.

"It was like air traffic control, was this," he says. "You had boats moving here, there, and everywhere." By tracking the trackers, the Kettering Group knew when to expect the launch

Max White, who used to work at the Royal Greenwich Observatory, predicts Soviet launches by following reports of tracking vessels like the Cosmonaut Yuri Gagarin *(bottom). Even launches of average comsats like Molniya-3 interest Kettering members.*

TASS/SOVFOTO (2)



of the Soviet's Buran space shuttle. "I'll call up Geoff and say, 'The *Gagarin* left the Black Sea and passed through Gibraltar two days ago.' Geoff will say, 'Right! It's off to Nova Scotia, isn't it?' That's it. Down goes the phone. It's another piece in the jigsaw puzzle."

White, an enthusiastic James Bond fan, obviously relishes the cloak-and-dagger aspects of his hobby. He says that he and Perry suspect their phones are tapped by British intelligence—"It's the cheapest way for them to get the information"—so they sometimes talk in code. Checking the shipping lists is "going boating"; an expected shipping movement might be "our friend has arrived."

Back at home, White settles into his alcove to await the Soyuz launch. There's nothing secret about it; if White had cable TV he could watch it live on CNN. Still, a Kettering diehard takes nothing for granted.

The launch goes off on schedule, and at 1:30 a.m., at the end of the spacecraft's second orbit, White's radio pulls in a staticky snatch of Russian. One of the cosmonauts, now over central Europe, is talking to mission control in the Soviet Union. White listens intently, scribbling the time, the frequency, and a few Russian words he recognizes. He rouses himself at 3 a.m. for more of the same. But during the fourth orbit, at 4:30, he sleeps through his alarm clock.

The next morning Perry calls to play a crystal-clear tape of a long conversation the cosmonauts had while White slept. Even the noises of a cosmonaut bumping about inside the capsule are audible. White has been one-upped.

The next afternoon, Perry, padding about his basement monitoring room in tweed slippers, is still excited about the Soyuz launch. Asked how he can summon up such enthusiasm after having heard so many Soyuz crews, even these very same cosmonauts, he replies simply: "But I've never heard Soyuz-TM 8 before, have I?"

Later that afternoon, Perry clambers down a slope to the road behind his house and strolls toward the sea. He skirts the tourist-filled fishing village and follows a dirt path toward the jagged, windswept Cornish cliffs. On the way, Perry tries to explain the source of the Kettering Group's obsession. "We're interested in anything that presents a challenge," he says. If the Soviets are doing something in space, Perry and his colleagues just like to be the first to know it.

And they like to get it right. Perry routinely predicts Soviet launch times, which he insists is no great feat. "We do the same sums as the Russians and we get the same answers," he says. Perry had predicted the Soyuz-TM 8 launch for 1:30 that morning, Moscow time. Even when the Soviets announced it would occur an hour earlier, Perry stuck with his prediction. This morning the UPI wire contains a brief item noting that the Soviets had pushed back their launch one hour after scientists had "recalculated the orbital paths." Quoting the story, Perry is exultant. Quite obviously, he says, someone in Moscow forgot the Soviet Union was still on daylight savings time. It was just a minor slip on their part, he admits, "but we were right!"

For Kettering Group members like Max White, tracking Soviet satellites is like fitting pieces in a puzzle.

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A look at the town where the Soviet Union's cosmonauts live and train reveals that little is changing—except the cosmonauts themselves.

Inside Star City

RICHARD SUIB

by James E. Oberg

For people of the stars, the Soviets have built a village of the stars and insulated it from ordinary, Earthside Soviet reality. It's called Zvyozdniy Gorodok, Russian for "Starry Town," but in English it's usually referred to as the more grandiose "Star City."

As a visitor approaching Star City, you drive along a typical suburban Russian road, past colorful semi-rural homes, picturesque woods and lakes, and occasional tall apartment complexes. You clatter over a railway crossing, through a routine security checkpoint, and past bus stands packed with commuters and shoppers, and suddenly you see a graceful arrow pointing to the right that reads "Zvyozdniy." The turn takes you through a birch forest and to another sign, larger and in concrete, that bears the same name. Straight ahead lies the visitors' checkpoint; a road leading to the town's residential section veers off to the left.

Barely 20 miles beyond Moscow's city-circling expressway, Zvyozdniy, at first glance, resembles nothing so much as an American military base. There is the same impression of planned access to the many shops (one of each kind), to laid-out parks and well-prepared squares for ceremonial activities, and to approved modes of mass transportation. As befits an isolated village, Zvyozdniy has its own schools, stores, and hotel.

But although about 4,000 people—cosmonauts, instructors, technicians,

A statue honoring cosmonaut Yuri Gagarin (above) dominates a Star City square. Many long to be the next Gagarin, but with a new, leaner space program, fewer cosmonauts will be filling future spacesuits.

JERRY ROSS/NASA

and their families—live here, none has made any personal mark on any of the structures of the town. The entire population could be replaced and the town would probably look exactly the same.

In fact, the population of Star City *has* been changing, in a way both subtle and profound. In response to the specific needs of long space station missions as well as to pressures created by the Soviet economy, a new generation of cosmonaut has been taking hold here—a smaller, younger group with a new style that contrasts with the traditional heroic mold of the past.

While early hero-cosmonauts were an eclectic bunch that included part-time artists, folksingers, UFO enthusiasts, and foreign car buffs, the new generation has to be much more single-minded about its careers. Since the Soviets are no longer recruiting cosmonauts in large numbers, there is greater competition for the fewer openings.

"The only people that should be cosmonauts are those who worked very hard to get there and are very serious about being a cosmonaut," says Sergey Krikalyov, a polite, serious 31-year-old who typifies the newer generation. From childhood, Krikalyov determinedly pursued his space career, picking his vocation, his university, even his hobby—sport aviation—to bolster his chances for space travel.

On February 1, 1988, a three-man crew was assigned to an end-of-year mission to the Mir space station. When the chosen candidate for flight engineer, a classmate of Krikalyov's named Alexander Kaleri, fell ill, Krikalyov was designated to step in. Eight months later he was in orbit, beginning a flight career that could last well into the next century and reach far beyond the moon.

The first of his class to fly and the youngest Soviet in space since 25-year-old Gherman Titov made an orbital flight in 1961, Krikalyov also has the distinction of being the first space traveler younger than the Space Age. He was born in Leningrad on August 27, 1958—almost 11 months after the launch of Sputnik. The 208 men and women who had preceded him into space had all been alive at the time of Sputnik's launch.

For Krikalyov, who says his greatest desire is to participate in another mission as soon as possible, a spaceflight must have been a dream come true. But when a journalist asked him just before his mission if he had any dreams, the cosmonaut replied brusquely, "No. I never dream. There's no time at all."

Dispassionate as his statement

NOVOSTI/SOVFOTO

sounds, there is some truth to it. The Soviets' space station-based program is making crew training increasingly complex and demanding. The development of new modules that can dock onto Mir requires Soviet crews to learn not only the intricacies of their Soyuz spacecraft and the Mir space station plus any experiments they will perform in space, but also how to operate, service, and repair the new Kvant science modules and new Progress-M freighter module as well.

Soviet officials finally concluded that this was too much for the traditional two-man crew and have decided to add to future flights a third crew member specializing in the modules. Budget constraints, however, have so far prevented implementation of this decision.

With a smaller cosmonuaut pool, officials assembling crews have fewer individuals to choose from. No more than 10 experienced cosmonauts are on flight status at a time. NASA, by contrast, has 45 experienced astronauts preparing for new missions, and over 100 active astronauts. Together with about 35 rookies, the total population of active cosmonauts is about 45, the fewest on duty since 1965.

"There are vacancies," admits Vladimir Shatalov, a 63-year-old former cosmonaut and chief of the cosmonaut training center for almost 20 years. "And for the time being we are deliberately refraining from filling them."

Since the late 1960s the Soviets consistently based their plans on an expectation of significantly more manned flights and so regularly recruited an excess of cosmonaut trainees. More recent economic constraints, however, have forced the Soviets to more tightly focus their program and more realistically assess launch rates. Hence Shatalov does not see an imminent need for more recruits: the expected flight rate is for only two or three Soyuz missions a year for the next decade or more. He is now training just five two-man teams for near-term missions, each including one rookie and one veteran.

Displayed under the glass of Shatalov's desk in his large office at Zvyozdniy is *Air & Space/Smithsonian*'s Space Explorers poster (April/May 1988). Many of the cosmonauts appearing on the poster owe their hero status to Shatalov's decisions. He sets the policy at every stage: screening, selection, training, winnowing, assigning to crews, medical evaluation, and retirement.

For the past 20 years cosmonaut recruitment has been standardized. Jet pilots in their mid-20s are selected for a decade-long apprenticeship (including university education), while civilian en-

NOVOSTI/SOVFOTO

Cosmonauts use a simulator to hone docking skills, which are essential to a space station-based program.

ROGER RESSMEYER/STARLIGHT

A training tank simulates weightlessness for cosmonauts working on a Mir mockup.

The Soviets' Swedish-built centrifuge helps cosmonauts adapt to the high-G punishment of liftoff.

TASS/SOVFOTO

Jubilant after the Soyuz-TM 7 mission, Sergey Krikalyov (right) and crew relax at the landing site.

gineers in their early 30s are recruited from the spacecraft industry and the mission control center, having been under observation in those jobs for years.

NASA, by contrast, has made a practice of selecting older pilots with impressive academic and flying credentials. NASA also recruits nationwide, drawing on a much larger talent pool, although candidates with high-visibility space-related jobs have been favored.

The flight engineer of a Soviet mission is almost always a civilian. The commander's seat is usually the only one open to military pilots, so that's where they are assigned—even on first flights. NASA's policy, on the other hand, has been to promote only experienced astronauts to the position of mission commander, and in the past 20 years the agency has made only two exceptions. Soviet practice has been the opposite: in the past 20 years, only five Soviet mission commanders in their first command posts have *not* been space rookies.

There are other major differences. In contrast to the NASA practice of giving everyone a turn—if they can wait long enough—the Soviet training process results in a high attrition rate. Of 80 men and women selected in the 1960s, fewer than half eventually made spaceflights; that fraction also held for classes picked in the 1970s. Contrary to widespread Western rumors, few died (and none in the mythical "secret launch disasters"). Most were dropped for academic or psychological weaknesses, or, as their bodies aged, for medical reasons.

Recent Soviet disclosures have identified a few such cosmonauts who spent 15 or even 20 years in full-time training only to fail a final physical exam and be grounded. A few came within a few days of actually being launched into space. Men such as Mikhail Lisun, Pyotr Kolodin, Lev Vorobyov, and Vladimir Preobrazhenskiy might but for a few bad breaks have become world-famous space voyagers instead of little-known footnotes whose decades of expensive training went completely unused.

Shatalov has denounced both the waste and the frustration involved in this feature of cosmonaut training, built into the program at the time he took over. "What is the sense of preparing a large number of cosmonauts if there is almost no chance of them going on a flight?" he asks. "First class pilots will be taken into the detachment, and their entire life will be spent in vain expectation. But such cases have happened."

RICHARD SUIB

Cosmonauts receive free housing in Star City's apartment complexes and cash bonuses for every spaceflight.

Some aging cosmonauts are still on active service, still awaiting their first journeys into space.

In recent years Shatalov has become point man for the cosmic side of *glasnost* and *perestroika,* speaking out candidly about the shortcomings and difficulties of the Soviet space program and reorganizing the bureaucracies where he could. When I visited him in March of last year as part of a television news crew preparing a special report on cosmonaut training, he was vehemently complaining about the inability of Soviet industry to supply his center with even basic essentials such as videotapes. He is also notorious for attacking Soviet industry's inability to apply space-developed technology to the improvement of industrial output.

With the new flexibility recently allowed under *perestroika,* he has finally begun reshaping the meaning of "cosmonaut." Shatalov cleared the duty roster of veterans of two or three flights, even those still vigorous in their mid-40s. Cosmonauts such as Leonid Kizim, Vladimir Kovalyonok, and Leonid Popov were transferred out; medical screening eliminated Gennady Sarafanov and Vladimir Vasyutin. Half a dozen others (such as Vladimir Dzhanibekov and Vladimir Lyakhov) were given desks to fly.

Most of today's senior pilots are from the relatively recent class of 1976: Anatoli Solovyov, Alexander Viktorenko, Vladimir Titov, and Alexander Volkov. The senior flight engineers were also selected in the late 1970s: Alexander Serebrov, Musa Manarov, Alexander Leveykin, Alexander Balandin, and one old-timer from 1973, Gennady Strekalov.

During my visit, the television crew and I met with two two-man cosmonaut crews then preparing for an April 17 launch to relieve the orbiting Mir cosmonauts. *Glasnost* had opened many doors, and everywhere we saw its refreshing effect on the attitudes of Soviet officials toward foreigners. At the town's Gagarin Training Center, we were permitted to see the cosmonauts in space station and spaceship simulators, in classrooms, during physical training, and during medical screenings.

Much of the training center is familiar to anyone who's been to NASA's equivalent compound south of Houston. Cosmonauts train in simulators hooked to computers that display data from actual flights. The medical screening facilities are like those you'd see anywhere. Classrooms are handsomely paneled. Oriental-style carpets are common, often covering recessed cable trays in the concrete floors. The gymnasium's exercise rooms and pools are first class.

It has been long-standing Soviet practice to withhold the names of spaceflight candidates until they actually fly, but recent advances in *glasnost* have made such a policy impractical. At Star City we happened to spend some time in the gymnasium's locker room, and there, of all places, I learned the previously secret identities of future cosmonauts: most of the fine wooden lockers had their names on them. Some were familiar: Alexander Kaleri (Krikalyov's classmate) and the space doctors Valeri Polyakov (then in orbit) and Gherman Arzamazov (his Earthbound backup), as well as physical trainers Victor

What's in a Name?

The names of current Soviet space trainees used to be a highly guarded secret. But with outsiders recently granted expanded access to Star City's cosmonaut training center, such secrets have become difficult to keep. The following list of current cosmonaut trainees, assembled by noting names on lockers outside the training center's gymnasium, appears here for the first time anywhere (full names were not used).

Sleuthing out the names of current cosmonaut trainees is more than a matter of space trivia. Such new information provides a starting point for assessing the Soviets' long-range intentions for manned spaceflight, especially when the individuals' background can be determined.

Public recognition of the names will make future developments easier to track, and may even improve the trainees' chances of graduating to spaceflight by making Soviet space planners more accountable for their fates.

Afanasyev
Artsebarskiy
Avdeyev
Bachurin
Boroday
Borodin
Burdayev
Chekirda
Dezhurov
Fedorov
Fefelov
Gidzenko
Grekov
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Isakov
Isaulov
Kaleri
Khludeyev
Komov
Korzun
Kozelskiy
Kuznets
Lisun
Malenchiko
Manakov
Moskvin
Novikov
Petrinchuk
Singatulin
Stelyanov
Stepanov
Suvorov
Tsibliyev
Yevstratov
Yumanov

JERRY ROSS/NASA (2)

Pre-launch tension shows on the faces of Anatoli Solovyov and Alexander Balandin in a suit-up room at the Baikonur Cosmodrome. Circles on the screen at mission control (above) show when their spacecraft will be in communication with the center.

Skovorodnikov and Igor Fetisov. Some we'd heard of from other sources: Nikolay Grekov, the rookie cosmonaut pilot; Ivan Bachurin, who has taken part in space shuttle testing. And some were completely new: N.N. Fefelov, V.N. Dezhurov, V.G. Korzun, I.F. Chekirda, and A.P. Artsebarskiy among them.

If the past is any guide, half of these men will fly in space in the 1990s, while the others will never be heard of again—that is, unless Shatalov's more realistic cosmonaut population allows them all a chance.

One locker label in particular caught my eye: "V. Illarionov." Valeriy Illarionov and I had met in Houston a decade and a half earlier during the Apollo-Soyuz Test Project. And while I marveled at the other hitherto-unknown names, a towel-wrapped Illarionov himself came out of the sauna, eager to catch up on the doings of NASA personnel he'd met.

An active-duty air force colonel, Illarionov had been a cosmonaut for a quarter-century, and at the age of 50 he was still awaiting his first launch. A few weeks after our meeting he learned how Gorbachev's military cutbacks would affect him personally: while remaining an active cosmonaut, he was being reclassified a civilian.

After the news was made public, Illarionov told a Soviet newspaper that

he believed older men such as himself were well suited for training as cosmonaut crew commanders. He suggested that a group of demobilized lieutenant colonels in their mid-40s be considered for selection as cosmonauts. As for the younger candidates, he said, they could take a turn waiting a few more years.

Whether Shatalov follows this recommendation remains to be seen. Virtually all the other assignments he has made speak of an accent on youth. And yet last year he selected an ace test pilot named Gennady Manakov to begin spaceflight training at the advanced age of 38, with the aim of an orbital mission sometime this year.

Shatalov says that bureaucratic infighting has made his job more difficult. "As the ones who have to do the job, we should pre-select people for specific programs, train them, and place orders for simulators which can't be produced quickly," he told a Soviet journalist a little over a year ago. That would require anticipating mission requirements years in the future, a capability Shatalov despaired of ever having. "We have no programs. Today I have no idea what we will have to do tomorrow or the day after. And even the current tasks are changing all the time."

Referring to the recent abrupt rescheduling of the Soyuz-TM 8 mission, whose crews we had videotaped, Shatalov complained bitterly: "There we were, having trained two crews for a scheduled expedition to the Mir station. Then we had to stand down. Now these crews have to undergo further instruction and be trained to do work with additional instrumentation modules which will be docked to Mir. But we still have no program for specific training for, say, next year, never mind the more distant future."

His outburst was probably an exaggeration produced by frustration, since we saw some facilities for long-term training being built at Zvyozdniy, including a large new pool for spacewalk training and a building devoted to space shuttle training.

Frustration is evident among the cosmonauts as well. Sergey Krikalyov was slated for several spacewalks from Mir early in 1989 to set up equipment for the arrival of an add-on section. When the module's launch slipped a year, the preparatory spacewalks were deleted from the schedule. But no one got around to informing the orbiting Krikalyov of the change before a newsman in an Earth-to-space interview casually asked how he felt about the cancellation. Caught by surprise, Krikalyov dropped his poised demeanor and blew up at mission control for allowing him to be blindsided by a newsman's innocent question.

It was a minor, if bitter, disappointment, and it's only temporary: young Krikalyov and his classmates have a lot of space-flying ahead of them, and the completion of Mir is only the first step. Glory and disappointment, triumph and failure, exultation and endurance all lie ahead, and the new Soviet space team is preparing to pick up the torch. If, as Shatalov intends, they prove to be as dedicated and talented as Sergey Krikalyov, they will be equal to the task.

ROGER RESSMEYER/STARLIGHT

Like their cosmonaut parents, the children of Star City live privileged lives.

NOVOSTI/SOVFOTO

To the Soviet public, space travelers—here the Soyuz-TM 5 crew—combine qualities of royalty and movie star.

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Allen R. Stubberud
Professor of Engineering, University of California, Irvine; former Chief Scientist, U.S. Air Force

The U.S. aerospace industry no longer presides in the world market as it did in the 1950s and '60s, when "Made in the USA" meant quality. The country has lost its technological luster, though not because it is spending less on advanced technology; it's spending more. Despite the passage of the Gramm-Rudman-Hollings act in 1986 and Defense Secretary Richard Cheney's new austerity measures, the United States continues to pay more for weapons systems and spacecraft than any other country in the world—indeed, more than the sum of what most countries in the world spend. But in this case, the folk wisdom "You get what you pay for" doesn't apply.

Quality in the aerospace industry has slid so far from its sterling reputation in the Apollo era because the industry has grown fat on government contracts. Getting the money for big projects has become more important than the projects themselves, and the ability to land big contracts is now rewarded more than engineering genius. This unfortunate shift in priorities is the result of the belief that money, not things to do, keeps people employed.

The ability to land big contracts is rewarded more than engineering genius.

The compulsion to hunt out contracts has afflicted the aerospace industry like a progressive disease, slowly sapping its vitality. To reverse the effect, the industry must recapture the excitement and strong sense of purpose that once assured quality in aerospace projects. It's easy for us to blame "the system" for our dilemma, but a change in management practices or new congressional action or even a government-wide reform of procurement policy will not restore integrity. The best hope for the industry is that its engineers will recognize the characteristic syndromes of its disease and take individual action to overcome them.

One of the most deceptive is the Perfect World syndrome. This syndrome ignores the fact that we must learn to live with imperfection, with failure, and with wear-outs. Instead, we insist that we can build programs with zero defects, 100 percent reliability, infinite life. These are noble goals, but in the real world they are unachievable. Rather than designing robust projects that can continue in the face of failure, we engineers spend huge sums of money trying to circumvent the inevitable shortfall. The *Challenger* accident was a massive shock because NASA had been operating on the premise that a fatal accident would not happen. Indeed, NASA continues to plan on the assumption that *now* the shuttle is perfect.

Rather than assuring perfection, this syndrome simply produces more expensive failures. The Inertial Upper Stage—it has gone by a variety of names, all with the acronym IUS—is a good example. The IUS is designed to boost a satellite from the low orbit reached by the shuttle or the Titan rocket into geosynchronous orbit. The Air Force insisted on a highly reliable vehicle, so the cost for a solid rocket motor soared from the usual $5 or $10 million to $120 million. It became not just a solid rocket motor but a super-reliable, super-capable vehicle that failed on its first two launch attempts.

The Bend Metal syndrome leads the contractor away from small-change research and right into production, ready or not. There is no real money to be earned in research, no money in paper designs. The money—and security—is in production. Congress can back out of a research program, but let it try to back out of an aircraft production run if parts are being built in every congressional district in the country.

Probably the most infamous example of this syndrome is former defense secretary Robert McNamara's procurement fiasco, the F-111. Having first fought the Navy over the aircraft, an Air Force design that was to be so advanced it would handle the needs of the Navy too, and then battled Congress through long, rancorous hearings, McNamara rushed the fighter into production in 1965 before the flight tests of the prototype had been analyzed.

Now is the time for aerospace engineers to take a good hard look at their industry and do what they do best: fix it.

All the problems of the prototype were built into the first production models. Although the problems were eventually solved, the fixes, according to one estimate in Richard Stubbing's *The Defense Game,* increased the cost of each F-111 from the original $4 million estimate to $17 million. The Air Force, hoping to purchase 1,200 fighters, cut the order to 513. The Navy canceled the contract after McNamara resigned.

An inevitable result of the Bend Metal syndrome is the Fix It syndrome. Because we insist on building systems for which we have no science and technology base, our products don't work. There are two conditions that prevail in the Fix It business. The first is that the company that gets to fix something is always, and without competition, the same one that built it wrong in the first place. And the second condition is that it almost always costs more to fix something than it did to build it.

All of the syndromes have developed, of course, in the competitive pursuit of money, the idol of the aerospace industry. Good top-level managers in this business have learned to detect the availability of big money with a finer degree of precision than was used to compute Apollo reentry trajectories. The best in the business figure out how to get more money than the amount available, a competitive technique thriving as the Oversell syndrome.

The Oversell syndrome will be particularly resistant to a cure. An aerospace company must oversell because all of its competitors are overselling. The rules of this game are: promise what you can't deliver, promise that it will cost less than it will, and just deliver something—anything. If it doesn't work, you then get to fix it.

It would be an oversight not to mention Congress' contribution to the disease affecting the aerospace industry. The Pork Barrel syndrome has created an aerospace contract award process that demands not excellence but maximum political gain. The aerospace industry learned long ago that the way to win a congressperson's heart is to promise jobs in the home district. A typical result is that pieces of the C-17 aircraft, the new heavy transport that McDonnell Douglas is producing, are built in nearly all 50 states.

Once aerospace engineers and managers recognize the disease characterized by these syndromes, we can combat it. We need not, and we should not, wait for politicians or some mysterious body of elders to save the quality of our work. We can fight back by cultivating intellectual honesty. We can take risks and expect failures and be honest about our chances for success. We can seek to work on projects we believe in, rejecting projects that pretend perfection but that will not result in anything more than the expenditure of money. This is difficult to do and requires a good measure of courage. What can engineers do if they are directed to work on projects they consider fantasies? They can seek more productive employment. Integrity may require engineers to change jobs until they establish a career working on real problems rather than a career chasing fantasies.

We can fight back by cultivating intellectual honesty.

We can refuse to oversell. At first we will lose to the competition. But establishing a reputation of care and honesty should win contracts over the long term. If the competition continues to oversell and we continue to lose, we can stop doing business with the federal government. There *are* customers in the world who seek honest engineering services.

We can become better educated and teach others; in the fight for quality, our principal weapon is our intellect.

Finally, we can demand quality from our colleagues and ourselves, rejecting solutions that merely divert problems to others. Perhaps we will occasionally have to blow the whistle when problems get out of hand. But we must take responsibility for the quality of our work and so begin to cure the disease that is threatening to kill our industry. ✈

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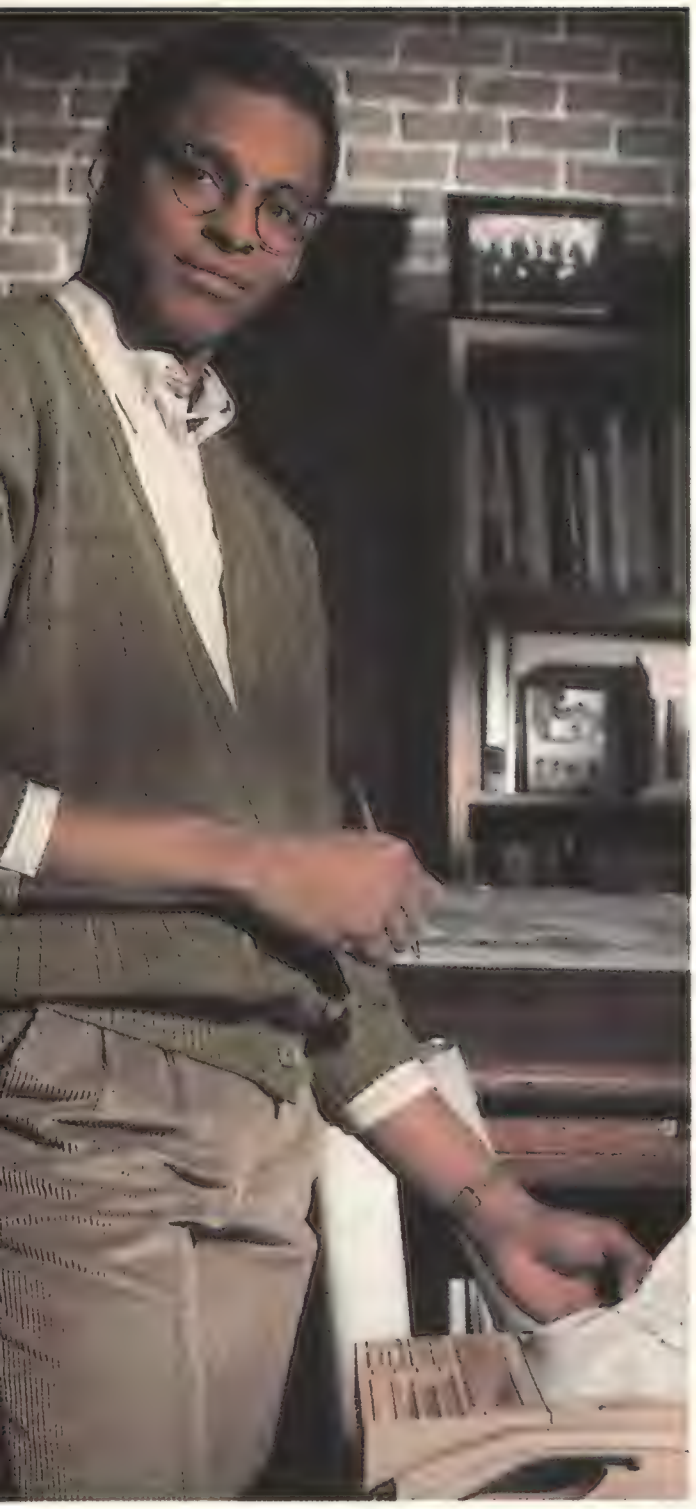

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The Battle of Britain:
50 Years Later
First in a Series

THE LAST OF THE FEW

During the summer of 1940,
Royal Air Force squadrons
altered the course
of World War II.

by Charles Fox *Illustrations by Ken Dallison*

In the afternoon, Billy Riggall liked to wheel himself out onto the front porch of his home, Great Meadow, and enjoy the sun. He was sitting there, a huge, hunched figure in a wheelchair, hands on his lap, left leg extended, when we drove away after spending a few days with him last summer. As we waved to him, I realized we were saying goodbye to one of the last of our heroes. Billy Riggall had fought and lived through the first great battle between nations waged entirely in the air.

Billy had pointed out to me that he flew Lysanders, not fighters, during the Battle of Britain. He had not been transferred to Spitfires until shortly after the end of the clash. By the strict rules of the Battle of Britain Fighter Association, he was not one of "the Few," but to me this is just splitting hairs. I was born in England in 1942, so I had just missed the Battle too. It had deeply affected me, though, and I felt profoundly grateful to this man.

The men who filled the ranks of the Royal Air Force between July 10 and October 31, 1940, when England had to go it alone against Germany, are the stuff of legend, as much as those who fought beside King Harry at Agincourt; perhaps more so, for the fight was brought to them and was not of their making. For me, the centuries between them have vanished.

As a boy, I did not meet up with any of the Few. Still, their language was all around: "whizzo prangs" for tremendous accidents, "gone for a Burton" for killed in action (Burton being a popular beer, the euphemism had the deceased off enjoying a pint), "crates" and "kites" for aircraft, "the ditch" or "briny" for the Channel or sea, "bounced" for being surprised by an enemy from above. This was the jargon of the Battle, and it had become part of our language.

For those of us growing up in London in the 1950s, the war was over, and yet it was everywhere: in the bombed-out sites where we played, walls suddenly exposed, stairs going nowhere, bathroom fixtures in midair, suspended by their pipes. And it had altered the human landscape, as evidenced by the rationing and the scrimp-and-saving of the adults. Nothing was wasted, nothing disposable. People didn't speak much about the war and what their part had been, for everyone had lost someone or undergone some frightful thing, and we were all, young and old alike, looking forward to what had been won.

The Spitfire, England's front-line fighter, had become a symbol of what was good and right about us English. As a boy of eight, I saw a shining Spitfire land at the airport in Nairobi. I thought it oddly petite for such a legendary weapon, but I would never forget the sight any more than I shall forget where I was when I heard that John Kennedy had been shot.

As boys we learned about the war from books and films. We confused Douglas Bader, the legless RAF fighter ace, with Kenneth Moore, star of the film about Bader's exploits, *Reach for the Sky.* Men like Bader were our heroes. But they were not like sport heroes; the Few were invisible—ghosts—and always would be. They had fought their battle, the battle of

battles, and there would never be another like it. Their contrails had been swept away forever by the wind.

On any fine summer day you could throw your head back and see the field on which they had fought. Lie on your back on the grass, surrounded by the sights and sounds and smells of precious summer, and there would be no end to your imaginings. It had to be a summer day, for the battle was fought in the summer of 1940, a season that was remembered for its long periods of clear blue skies.

The British forces in France had been evacuated at Dunkirk in late May and early June. Soon the Luftwaffe would be over England. And within weeks of Dunkirk, the RAF was sparring with the first of them over the Channel as Hitler imposed an air and sea blockade upon England. July 10, a day of sharp combat in the skies over the coast, marked the first of a series of engagements that would collectively come to be known as the Battle of Britain.

My father had waited for three days on the beach at Dunkirk for one of the small boats that was to evacuate 338,226 Allied soldiers. Along with the others he had cursed the absence of RAF air cover to drive off the Stuka dive bombers and strafing Messerschmitts.

"We were held back," Billy Riggall told me. "They wanted to save us for the fight they knew was to come." It was odd that even after all these years, Billy was still confused about Dunkirk. In fact, Winston Churchill was fully committed to covering the retreat, and the RAF lost 98 precious Hurricanes and Spitfires protecting the beaches. One of the pilots shot down over Dunkirk was Alan Deere, with whom I spoke after I'd left Billy.

"It was a lucky shot from the tailgunner of a Dornier 215," he said. He went on to tell how he had crash-landed his Spitfire on a beach in France and been evacuated on a destroyer. Deere had flown 14 sorties and shot down at least four aircraft while covering the retreat. The cloud that had covered Dunkirk had kept the Luftwaffe away but also prevented the helpless armies on the beach below from seeing the fighting in the air above. When the evacuees aboard ship saw Deere's RAF uniform, they greeted him not with praise but with questions like "Where have you chaps been?"

Once Hitler realized we were not going to surrender, Germany prepared to invade England. But first it would need to destroy the RAF. Hermann Göring, the Luftwaffe commander, estimated England could be knocked out of the skies in four days, given good weather. My mother was farming for a man who had joined the RAF. She saw the fighting above and knew well what lay upon the outcome. The fall of France, she once told me, had been perhaps the most depressing moment of the war. My father had warned her that if there was an invasion, he would be too busy to come to her rescue. "You'll have to get on with it," he'd said.

Billy said his squadron was pulled back from the south of England to defend Liverpool, near his home ground. He pa-

"The Few"

From a speech given to the House of Commons by Prime Minister Winston Churchill on August 20, 1940:

The gratitude of every home in our Island, in our Empire, and indeed throughout the world, except in the abodes of the guilty, goes out to the British airmen who, undaunted by odds, unwearied in their constant challenge and mortal danger, are turning the tide of world war by their prowess and by their devotion. Never in the field of human conflict was so much owed by so many to so few.

* * *

From The Fringes of Power: 10 Downing Street Diaries 1939-1955 *(John Colville, Norton 1985), diaries written while Colville served as Churchill's private secretary:*

August 20, 1940 Although the gallery was crowded I made my way down to the House to hear the P.M. speak. It was less oratory than usual and the point of chief interest to the House was the account of the bargain with America about the lease of air-bases . . . . On the whole, except for bright patches—like that about "the Führer's reputation for veracity," which had a big success—the speech seemed to drag and the House, which is not used to sitting in August, was languid.

trolled the southwest coasts, flying sweeps in his Lysander over the Atlantic, looking for German submarines in the sea lanes that led up to Liverpool and Britain's back door. "They were afraid that the Germans would do what they had done at the Maginot Line in France—go 'round the end—and hook up with the Irish, who didn't much care for us either," he said.

Billy's Westland Lysander was a large, high-wing, single-engine workhorse that could get in and out of tight quarters—definitely not a fighter. To find a front-line Hurricane or Spitfire pilot who'd been stationed in the south of England during 1940, I decided to seek out the widow of Sir Douglas Bader, England's most famous Spitfire pilot. She would know.

Lady Bader told me how she and Sir Douglas had met in a bunker—the kind you find on a golf course—and ended with the story of the night he died. It was 1982, and they were returning from a London dinner where he had made a speech. He hadn't felt well, and she'd tried to persuade him not to go at all, but he had felt obliged to honor his commitment. On the way home he asked her to drive. "So I knew something was wrong," she explained. "He always drove." He died beside her, peacefully, in the dark, this great hero. She had driven on home with his body.

Lady Bader suggested I try "Johnnie" Johnson; credited with 38 kills, he had been the highest scoring British ace. But Johnson was away in Florida, so I called Squadron Leader Norman Hancock.

Wing Commander Tan Gleed

Wing Commande James E. (Joh Johnson Top Batt of Brita ace.

'A' flight No 54 Squadron in June 1940

Group Captain Alan C Deere

Eric "Sawn-Off" Lock

Squadron Leader James H. "Ginger" Lacey

An American with 609. Plt Officer EQ "Red" Tobin

Canadian John Kent Flight commander of the Polish 303

Eric James Brindley Nicolson, only fighter pilot awarded the V.C.

Flying Officer Jan Paivel Falkowski

Wing Commander "Paddy" Brendan Finucane

Australian Flt Lt Pat Hughes

Flight Lieutenant John Dundas

Group Captain Douglas Bader

ts of the famous 303 Squadron

Adolph G. (sailor) Malan a South African.

F. G. Lovell Grigg

Flight Lieutenant John Ignatius "Iggy" Kilmartin

Squadron Leader RR Stanford Tuck.

The Sharp Edge

Two fighters bore the brunt of the fighting for the RAF: the Supermarine Spitfire (top) and the Hawker Hurricane. Both had been designed in the 1930s to meet a requirement for a fast monoplane mounting eight guns, deemed the minimum armament needed to shoot down a bomber within the two seconds a pilot was thought capable of keeping his foe in his sights.

Both fighters were powered by the Rolls-Royce Merlin V-12 liquid-cooled engine, rated at 1,030 horsepower. The

Hurricane, which entered service first, was built of tubing and wood, with fabric and plywood covering the fuselage and metal skin on the wings. The more modern Spitfire was nearly all metal and considerably faster. During the Battle, RAF tactics called for the Hurricanes to go after the Luftwaffe bombers while the faster Spitfires tangled with the fighter escorts.

Throughout the summer, both fighters scored in approximate proportion to their numbers: roughly two to one in favor of the Hurricane. Although Hurricane losses were higher, the older airplane could absorb more punishment and was easier to repair and return to service after being damaged.

He suggested I contact Peter Barthropp, whom he described as a "colorful character."

For the past 30 years "Paddy" Barthropp has owned and run a luxury car-hire business next to London's Belgrave Square. I found him in the office on a Sunday morning; a brace of pheasant and a shotgun barrel lay upon the receptionist's desk. Inside, Barthropp introduced me to Bill Stapleton, a friend with whom he had been shooting that morning.

Barthropp is a slight, sandy-haired man, with the only concession to his 70 years that I could see being his half-glasses. Stapleton is a dignified man with a dark complexion. They were a bantering pair of old friends who had spent years together in a prisoner-of-war camp in Germany. Barthropp was shot down over France in 1941. Stapleton had been shot down over Dunkirk in his Spitfire.

I told them my father had been on the beach below. Stapleton laughed. "I bet he complained we weren't there," he said.

"Well, we were," Barthropp said. "Bill can attest to that."

"*You* weren't," Stapleton pointed out.

I asked Stapleton how he'd been shot down.

"Flew over the shore battery at 800 feet," Stapleton said. "Perfect height for ack-ack guns."

He ditched offshore and was picked up by the Germans. "They had a far more efficient air-sea rescue operation than we did," he said. "They were altogether better organized for this war than we were. The first thing that happened to you when you ditched, for example, was that you were strangled by your tie."

The German fliers wore a kind of "battle dress" before the term was even known in England. It was open at the neck so you could turn your head easily and comfortably. "When the Battle of Britain started it was compulsory in the RAF to fly in uniform, which was a Saville Row or Burberry suit and tie," Stapleton said. "It wasn't until later they let you wear roll-neck sweaters and scarves and be comfortable. The Germans were just way ahead. They didn't give privileged people a commission and debase the other ranks. You had to earn your commission. The Germans were preparing for a war. They didn't train you to be a good 'Bar Officer,' good at 'messing.' They just got on with it."

These were passionate words, born beneath a good nature and, one suspected, of bitter experience. The walls around Paddy Barthropp's desk were decorated with pictures of Spitfires, and there was a framed banquet invitation signed by all the legendary heroes from the Battle. I saw the signatures of Douglas Bader, Ginger Lacey, and Alan Deere. "Professional heroes," Barthropp and Stapleton called them. "Bog rats" was the term they reserved for themselves.

On August 13, Flying Officer Barthropp, the 19-year-old son of a racehorse trainer, volunteered for Fighter Command. He had about 300 flying hours on Lysanders and was sent to an Operational Training Unit at Hawarden, where he was to be given 20 hours and five minutes training on Spitfires by officers who had never been in combat. There had been no "adventure" in Spain before the war to sharpen their skills, as there had been for the German pilots of Willi Messerschmitt's Bayerische Flugzeugwerke Bf.109, the Luftwaffe's front-line fighter and the principal adversary of the British Spitfires and Hurricanes.

The Spitfire was an easy airplane to fly, Barthropp told me. It had six basic instruments, including a direction indicator ("which was very easy to topple—you only had to be a little bit rough on the stick"), magnetic compass, altimeter, turn-and-bank indicator, and airspeed indicator. "She could take a lot of Gs," Stapleton said, "more than the pilot could. She wasn't the easiest plane to land, though." The Spitfire had a very narrow

undercarriage, which allowed room for guns: four .303 Browning machine guns mounted in each wing. "She was a beautiful plane," Barthropp said. "All metal, the most modern thing there was. The Hurricane was a bit cumbersome by comparison. Like flying a lorry rather than a sportscar. But it could take a lot more punishment.

"We didn't have any idea of what the Germans had 'over there,' " Barthropp went on. "They told us the 109 was made of cardboard and crap like that and couldn't make a climbing right-hand turn. In fact, we were to find out it could make a climbing right-hand turn much better than we could."

The little Luftwaffe fighter had first appeared in 1935. It had a top speed of over 350 mph and could climb more steeply than the British fighters. However, it couldn't turn as tightly, and early on, it didn't have armor to protect the pilot—although it did have bullet-proof fuel tanks, which the British fighters did not. It had one lasting advantage: it could push over into a dive without a loss of power. The Hurricanes' and Spitfires' Merlin engine had a float-type carburetor, which caused it to cut out under negative Gs.

Most significant was its limited range: officially it was as much as 412 miles, but its actual operating radius was about 100 out and back, giving it something like 10 minutes' fighting time over London. Alan Deere pointed out that it was not fitted with long-range tanks because the Luftwaffe expected swift victory. They hadn't allowed for the kind of tenacity exhibited by such men as these English.

While Barthropp trained, the Battle of Britain raged. Through July and August, the Luftwaffe carried out a deadly and intensive bombing attack on the RAF's front-line fighter stations. At the onset the Luftwaffe's main force consisted of approximately 1,300 medium conventional bombers, 300 dive bombers, 800 single-engine fighters, and more than 300 twins. Men, not airplanes, were RAF Air Chief Marshal Hugh Dowding's worry. RAF schools were slow and pilots had to be carefully preserved. By July 10 the RAF had 1,253 fighter pilots. The Luftwaffe intelligence fairly accurately estimated RAF strength to be 50 squadrons equipped with a total of approximately 600 aircraft.

One of Britain's greatest assets was its well-knit defense system of observers, radar, and fighter control. The Germans underestimated its effectiveness even though they had known about it well before the war. They felt that such technology only made the RAF less flexible, and Göring advised that mass raids would confuse it.

The Luftwaffe also underestimated the loyalty and sheer aggressiveness of men like Deere and Flight Lieutenant James Brindley Nicolson of 249 Squadron. In combat on August 16 Nicolson earned the only Victoria Cross awarded to a Fighter Command pilot during the Battle. Bounced by a twin-engine Bf.110 fighter, his Hurricane was hit and he was bailing out when the 110 passed him. He dropped back into the cockpit and shot down the German. Only then did he realize that he himself was on fire and bailed out, badly burned. He played dead in his parachute harness to throw off passing enemy fighters as he descended, but was then hit by shotgun pellets loosed by a nervous Home Guard sentry as he neared the ground.

Deere is a New Zealander. He was a 22-year-old law student when he came to England and learned to fly. After he was shot down over Dunkirk he returned to his squadron. On July 9 he collided head-on with a Bf.109 and managed a forced landing at Manston airfield. On July 24 his Spitfire suffered damage in a dogfight, but he managed to land it back at his base at Hornchurch. On August 15 he chased a pack of 109s back over the channel. Above Calais they turned on him and shot him down, but he managed to bail out over English soil. On August 31 he was taking off from Hornchurch during a raid on the field. A bomb landed directly in front of his Spitfire and blew off the engine and a wing. Deere was pulled from the wreckage with a concussion and cuts on his face. "A formation of Heinkels got in under the radar," he said, "and we were got off the ground late." A fortnight later he was taken out of the battle for an eight-week rest. He had shot down four aircraft.

It was during this period that Paddy Barthropp, the self-described bog rat, went into action. He had left the Operational Training Unit to join 602 Squadron. "We went in my little motorcar," he remembered. "An Austin Seven, called 'Henrietta.' My friend Gerald Fisher and my dachshund Blitzkrieg and I." He was one of the youngest pilots in the battle. "Six-oh-two was an auxiliary squadron," he said. "Weekend fliers, usually rich, because [before the war flying] was a hobby to them. But half of them had been killed or wounded, so they sent us regulars in."

He reported to Tangmere-Westhampnett on August 17. "We clocked in and reported to the station adjutant, 'Crackers' Douglas, a flier in World War I. He did everything from write letters to bereaved parents to wake us up. He was our nanny, really." Barthropp was shown to his quarters, which consisted of an old farmhouse that housed four or five other pilots. The day before, a large force of Stukas had attacked Tangmere. "They'd done a great job, really," he said, "destroying a couple of hangars and killing a lot of people. . . . It was a bit of a mess when we arrived, people running around, the place still smoldering. I wasn't frightened. When you're 19 I don't think

you get frightened. Scared, yes. I think we were little John Waynes, running around."

This was one of the last raids on Fighter Command's forward fighter stations. The RAF's back was almost broken, but the Luftwaffe, ignorant of this, switched to bombing London. The young pilot was assigned an aircraft and the call name "Hurdle."

Barthropp was put on dawn readiness. The pilots slept in the dispersal room, which had a dartboard on the wall beside the enemy aircraft recognition poster. They slept in their trousers and pajama tops on camp beds under smelly blankets with flying boots and leather jackets by the bed. At dawn a bell rang and somebody brought them some awful tea. They got up and waited for the telephone in front of the airman at the ops desk to ring—a tense business.

"When it first rang, it was the airman's friend ringing to ask, 'How are you?' " Barthropp recalled. "But then it rang again, and this time it was 602 Squadron scramble. 'Angels two-five!'

"Once you were running for the aircraft it was all right," he said. "You had an airman waiting to help you do up your parachute straps. It took about a minute to get airborne. I had a lucky black cat thing that some bird had given me. I wasn't carrying it the day I was shot down, funnily enough."

Barthropp also carried a revolver stuck in a flying boot, maps that would rarely be referred to, and a yellow Mae West life jacket. He took off, set the gun button to FIRE, and climbed to 25,000 feet. The CO was vectored onto a flight of incoming enemy bombers. Barthropp wrote in his log: "Thousands of them. Damage 109. Still thousands of them. Fired, but nothing confirmed. Intercepted 25 Dornier 17s. Fired on them, but without any apparent result."

"You had 13 seconds of actual firing," he said, "then you were out of ammunition. Our guns were harmonized at 250 yards. That's how they came. It was a bit like trying to shoot a target with a 12-gauge at 100 yards. 'Hawkeye' Wells probably harmonized his at 50. The optimum was probably 100 yards. Hawkeye got a Focke-Wulf at 40. You had to yaw the aircraft slightly to aim. Tracer showed as little points of light, but it was very unreliable. It wasn't going where you thought it was." There were quarter-rear, beam, quarter-front, and head-on shots, each progressively more difficult. The head-on could be suicidal, but against bombers it could also be extremely effective.

"Ideally," Barthropp said, "you got 200 yards behind a 109, followed him around, and shot him down. But I never did that in the Battle. I was a lousy shot," he admitted. "I got a Junkers 88 over the Isle of Wight. I know I did because Findlay Boyd, my number two that day, was out of ammunition. It crashed into the sea five miles off Brighton Pier. Nobody got out. I have the names of the crew somewhere.

"When you got back from a sortie," he continued, "you would get out and go see the intelligence officer when they refueled and re-armed the plane. For each pair of aircraft there was a fitter [engine], rigger [controls], armorer, instrument basher, and the electrician. They worked 'round the clock on the open field or in unheated hangars to keep the fighters airworthy. It took about a hundred men to keep a fighter squadron combat-ready."

The early versions of the Spitfire carried 85 gallons of aviation gasoline, most of it in the wings but part of it located in a header tank behind the engine and just in front of the cockpit. "The tank was right in front of your chest, so that if you took an incendiary you were the first to go," Barthropp said. "Your fuel gauge was your main instrument, I'd say, followed by your airspeed indicator."

Young pilots had the shortest life expectancy in the Battle, as Crackers Douglas must have known well. "The thing about being a junior bloke was your ammunition," Barthropp explained. "There were four kinds: ordinary ball, armor piercing, tracer, and explosive. Explosive [incendiary with a delay] was called De Wilde, after the inventor. It meant you could see when and where you were hitting. The flight commanders were a bit crafty. They used a lot of explosive, which was scarce. But us bog rats got the ball because they were short of the rest. The more experienced you were, the better load you got, and fair enough."

When Barthropp left the intelligence officer, he went back to the dispersal and waited for the others to come back in ones and twos and "maybe there'd be somebody missing. You'd have a game of poker, feed the dog, and wait to be scrambled. At the end of the day you were 'released' and you could do anything you liked. We used to put Blitzkrieg in the back of the Austin and go over to Tangmere and play a game of squash and then go down to the pub. You could come home whatever time you liked."

It was difficult to get Barthropp to talk about those times very seriously. Stapleton had to leave, so he took the brace of pheasant, thanked Barthropp, and headed toward the door. Suddenly serious, he turned to me. "Before we knew about Dachau and all that, we thought we were fighting an 'honorable' enemy, as we had in the first world war," he said. "The Germans were 'bully boys' and we'd had enough of all that, but we hadn't seen the hideousness behind the Nazis. The Polish pilots had, so they had the real killer instinct, but we hadn't."

With that he was gone, shotgun beneath one arm, pheasants dangling from the other hand.

Barthropp watched him go. Then he said, "About half the people I was with in the [squadron] farmhouse were killed, I'd say, before the war was over. You were sad for a minute, but there was so much going on. Things were very basic in those days. It was just a matter of survival. If you did something stupid you were going to go in." He thought for a moment, then added, "When you took off all you could see was lots of little villages and lots of little railway lines and you knew that they were your villages and your railways and that if you got shot down all you had to do was bail out to get back home. The Germans had to fly all the way home.

"The airplanes were about the same. The guys were about equal. Being over our home ground gave us the psychological edge. That and 20 miles of sea and their bad tactics is what saved us, as usual."

He thought further. Finally he went on. "World War II was my Mecca. It wasn't a nationalistic thing. We were just doing a job, for which we were paid the princely sum of 11 shillings a day.

"When I look back I have memories of an awful lot of fun, with an awful lot of decent, lovely guys, WAAFs [Women's Auxiliary Air Force], pints of beer at the Unicorn in Chichester, and nights at the Charley Kunz nightclub in Bognor. Blue skies. You had a lovely uniform. You flew around shooting Germans. Landing at night. You were the hero of the hour, let's face it. Every pub you went into, they bought you a beer."

I asked him what had been done with what was won. He shook his head. "Not much," he said. "I hope we do better in the next 50 years."

Johnnie Johnson was back from Florida, so I called him the day before I left England. A woman answered and said he had taken a dog to the vet. When I called again he said he hadn't shot anyone down during the Battle. Before the war was over he would shoot down more than any other RAF ace, so I asked him about the technique anyway.

"What was needed was height and sun," he said. "The average fighter pilot couldn't shoot. He could fly but he couldn't shoot. I think those of us who were brought up in the country and learned to shoot ducks when we were young knew about range and very quickly learned about deflection shooting. . . . We knew how to lead and we knew about range. Very hard to estimate."

It was Johnnie who had originally put me on to Alan Deere. I asked Deere if, like Barthropp, these had been his halcyon days. He was taken aback.

"What," he said, "before the war?"

"No," I said, "the Battle, the summer of 1940."

"Good God no. Hectic more likely, not halcyon."

I asked him if he had any special technique in air-to-air combat.

"No," he said, "I wasn't a good shot. I just got in there and got at them."

On September 17 Hitler postponed "indefinitely" his long-planned cross-Channel invasion and turned his attention east, toward Russia. The next day, the German invasion fleet began to disperse. It would never be reassembled; the Battle of Britain had been won. It was clearly a seat-of-the-pants battle, and a unique chance for us, even now, to look up and see the thread by which we dangled.

Air Vice Marshal Alan Deere eventually scored 21 confirmed victories in World War II. He lives in England.

Squadron Leader Paddy Barthropp was awarded the Distinguished Flying Cross. He was shot down over France in 1941 and held prisoner for the rest of the war. He lives in London.

Wing Commander Bill Stapleton is retired and divides his time between London and the country.

Air Vice Marshal James Edgar "Johnnie" Johnson became the highest scoring RAF ace with 38 victories. He lives in England.

Lieutenant Colonel Robert Hamilton Douglas Riggall (he had both an RAF and an Army commission) took the first wing of Spitfires to Burma and was shot down over the jungle. He retired after the war due to reasons of health and died shortly after granting these interviews at his home on the Isle of Man. ✈

Improbable Journey

How two pilots flew two little airplanes around a very big world.

by Dan B. McCarthy

Tired but happy, the two American pilots sauntered into the operations office at England's Croydon Airport on a sunny afternoon in August 1947. As they completed their arrival forms, the operations officer inquired, "What are you doing here?" It was the question George Truman and Clifford Evans had been waiting for. "We're flying these little Pipers around the world!" Truman proudly declared.

The clerk didn't look up from his papers. "Oh," he replied.

It wasn't the response the pilots had expected. After all, they had just crossed the Atlantic Ocean in two Piper Super Cruisers, becoming the first to make that jump in modern light aircraft. They intended to add to their first by flying their small aircraft around the world—a journey of an additional 21,000 miles.

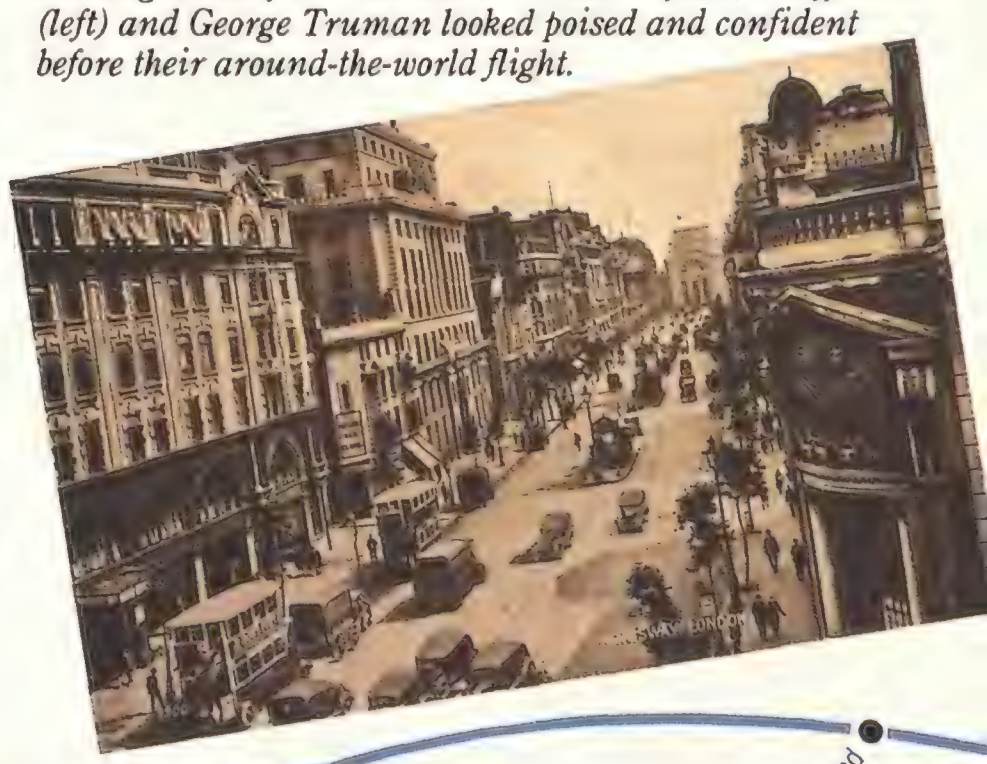
PHOTOS AND MEMORABILIA COURTESY MRS. GEORGE TRUMAN

The record-setting trip had begun 19 days before their deflating arrival at Croydon, when the pair took off from Teterboro, New Jersey. But it got its real start the previous year, on a hot August afternoon at Maryland's College Park Airport. Truman, a stocky 38-year-old, and Evans, blond, blue-eyed, and still boyish at 25, were both Army Air Corps veterans working at the Maryland field as instructors for the Brinckerhoff Flying Service. A student of Truman's had just bought Piper Aircraft's latest model, the three-passenger PA-12 Super Cruiser, and Truman was assigned to check him out on it.

The Super Cruiser was an enlarged 100-horsepower version of the popular J-3 Cub, an airplane so widely known that for decades "Piper Cub" became a generic term for all light airplanes, this new model included. The Cruiser impressed Truman as well as the rest of the flying school.

As the bright summer days yielded to the more troublesome

Although other fliers labeled them "damn fools," Cliff Evans (left) and George Truman looked poised and confident before their around-the-world flight.



weather of autumn, instructors and students would gather around a potbellied stove in the operations office, waiting for the weather to clear. The PA-12 dominated their talk.

During one of these sessions, Gene Pace, a brash instructor from North Carolina, made a tantalizing suggestion: with extra fuel tanks and many stops, he conjectured, a Cruiser could circle the globe. Truman and Evans were quick to agree. But George Brinckerhoff, the veteran pilot who operated the flight school, gruffly declared that it was impossible to fly an aircraft that small around the world.

"Mr. Brinckerhoff was a man who didn't like to lose an argument around the office stove," Truman told me in an interview many years later. "And most of the pilots agreed with him." Still, the idea grew more enticing. By the next day, Truman and Evans had world aeronautical charts in hand.

In secrecy they began planning routes, equipment, finances, and sponsors. "We wanted to do it ourselves, without a lot of eager beavers elbowing in," the pilots wrote in an account of the flight that ran in *Collier's* magazine. "And besides, if the old geezer who ran the airfield [Brinckerhoff] heard about it, instead of helping us, he would probably can us as a couple of crackpots." After a deluge of letters from the two pilots and some corporate hemming and hawing, Piper Aircraft agreed to donate two slightly used Super Cruisers—"to get rid of us more than anything else, probably"—and replace the aft passenger seats with auxiliary fuel tanks. Truman named his aircraft *City of the Angels,* after his adopted hometown of Los Angeles. Evans, a District of Columbia resident, named his *City of Washington.* Lycoming, a division of the Aviation Corporation, supplied two brand new engines for a token one dollar each, and the Bendix, Sperry, and Kollsman companies donated radios and instruments. Evans tapped a savings account, borrowed from relatives, and sold his car to cover whatever they couldn't beg or borrow. Truman cashed in some bonds and mortgaged his family's trailer home.

As the pilots acquired equipment, their plans spread rapidly through the aviation grapevine. They became known as "the damn fools who want to fly around the world in Piper Cubs." When he turned over the PA-12s to the two pilots, Piper president William T. Piper had asked, "Why in the hell do you fellows want to make a fool trip like this?"

It was a reasonable question. Piper aircraft were supposed to hop to the next airport, not the next country. Flying long distances at 100 mph and low altitudes—particularly over the oceans—would be grueling at best and foolhardy in poor weather. But the pair denied they were looking for glory; they said they wanted to prove that the flight could be made by anyone taking the proper precautions.

So Truman and Evans stressed safety over speed. Wiley Post had made a similar journey in just over a week in 1933. But his Lockheed Vega, the *Winnie Mae,* had five times the horsepower of the little Pipers and flew only 15,596 miles. Truman and Evans, denied permission to fly over Soviet borders, were forced to take a more southern route that was 10,000 miles longer.

They figured six weeks would cover it. "We're going to take our time and see the sights like regular tourists," Evans told a *New York Times* reporter. They planned sightseeing stops in every large city from London to Juneau.

On August 9, 1947, Truman and Evans took off from New Jersey, bound for Presque Isle, Maine. They had between them two suits, four shirts, some Benzedrine stimulants, Esso credit cards for fuel and oil, letters of introduction in various languages, and $850 for landing fees, hotels, and emergencies.

Ten minutes northeast of Manhattan, they lost sight of each other in the overcast. "We're lost, but we're making good time," Evans joked into his microphone, coining a phrase he would use throughout the flight. They kept in touch by radio and flew on instruments until they broke out of the clouds over Bangor, Maine. Finally, an exchange of signals with the Bangor airport helped the two Cruisers find each other and get back on course for Presque Isle. After that, the aircraft were never separated for more than a few minutes.

The next leg of the journey, from Maine to Goose Bay, Labrador, passed without incident, but "what awaited us at Greenland was nightmarish," Truman recalled. The pilots had to feel their way up a fjord with four elbow bends in semi-darkness to Bluie West One Army Airbase. Men with torches

A small flurry of concisely worded postcards charted the pilots' stops on their global odyssey.

were stationed on the sheer faces of the cliffs to guide the pilots in, and spotlights lit the field. After a nerve-wracking landing, the pilots were hospitalized for six days with influenza and exhaustion. Then a front brought foul weather and socked in the airbase for an additional week. "If we had been out to break any speed records, Greenland was where we would have turned for home," Truman later said.

Back in the air and en route to Iceland, 950 miles to the northeast, the pilots raced another front and barely beat it to Keflavik. Within 30 minutes of their landing, weather closed the field for what turned out to be two days. With less than one-eighth of the trip completed, the Cruisers were more than a week behind schedule because of the notorious weather systems of the North Atlantic.

The pilots faced the Iceland-to-England leg of the flight with more basic matters on their minds. Truman recounted that their rubber exposure suits, worn in case of a forced landing at sea, "pinched our butts and chafed our knees" so badly that 11 hours and 45 minutes out of Iceland they landed at Newtownards, Ireland, instead of London, mainly to change their clothes.

They then flew on to Croydon and the impassive operations officer. There, the pilots related in *Collier's,* they found an England of "gray stone buildings, gray polite people, something called lime squash, and air races at Lympne."

Evans (speaking, above) said he and Truman planned to travel more like sightseers than record-setters; a diligent tourist, Truman collected cancelled stamps from all the places they visited (below).

On the way to Paris, the pilots dropped in on Hedel, a Dutch village that Evans' church had adopted to help residents overcome the devastation of World War II. The villagers asked the pair to circle the town as they departed on their flight south. "But not too low," the residents cautioned. "The children remember the bombings." The Cruisers buzzed the village gently, dipping their wings in farewell, then flew on to France.

During the two-day Paris visit, someone scribbled on Truman's Cruiser, "Kilroy was here. And I was here before Kilroy!" Pope Pius XII added his signature to the sides of the two Cruisers in Rome, where both pilots learned to eat spaghetti Italian-style. Evans told the Washington, D.C. *Times-Herald* newspaper that "it was quite all right to make slight slurping noises."

The next leg of the flight, Rome to Cairo, was 1,350 miles. It was the longest nonstop segment so far, but the blue Mediterranean was a piece of cake after the North Atlantic. Truman and Evans arrived at Cairo just four minutes off their estimate, but to make up for earlier lost time, they had to settle for viewing the pyramids from the air.

They fared less well flying from Cairo to Baghdad, when they encountered the roughest turbulence of the entire voyage. Jostling around for three hours east of Cairo exhausted the fliers. "And we both had stomach cramps, not being used to Egyptian food," Truman recalled. They spotted a Royal Air Force base in Iraq on their maps and Truman radioed for permission to land. The request was denied, so the pilots were forced to press on to Baghdad, three more hours away.

At Baghdad, the fliers were invited to a cocktail party at the American Embassy. There, officials persuaded them to add a stop at Dhahran, Saudi Arabia, where hundreds of Americans were employed by Aramco, the Arabian-American oil company. The detour produced mixed results.

The airport at Dhahran had procedures and paperwork for handling foreign military and commercial aircraft, but none that covered civilian flights. The pilots languished for six days in 130-degree heat waiting for a departure clearance.

While they were killing time in a Dhahran restaurant one afternoon, a familiar North Carolina drawl announced, "I hear that there's a couple of hot-rock Cub pilots in our midst, flying around the world. Is that true?" It was Gene Pace, the flight instructor whose casual remark back in Maryland had started the whole thing. Pace, who was now flying for Aramco, was based at Dhahran, and that evening the friends got together for a small reunion.

Finally released from Saudi Arabia, the Cruisers flew on to Jodhpur, India, where the Maharaja of Jodhpur's personal pilot invited them to the palace. "The Maharaja was something right out of *Arabian Nights*," Truman said. "He was just 23, weighed 300 pounds, and loved automobiles—he had 125!" He also loved machine guns and was disappointed that his visitors had not so much as a pistol between them.

After a night in the palace, the pilots headed for Rangoon, Burma. Headwinds forced an unscheduled stop at Akyab, a small Burmese village on the Bay of Bengal. At Akyab's dirt airstrip, two American missionaries took in the pilots until the winds died. The area was full of bullfrogs. "One priest told us that if we heard a frog croak five or more times in succession we'd have good fortune on our return trip home," Truman recalled. "I counted seven croaks that night. And Cliff said he counted nine."

Good fortune accompanied the pair to Rangoon, Bangkok, Hanoi, and Hong Kong, but then it ran out—a typhoon in the Formosa Straits grounded them for six days. The flight to Shanghai was thwarted by 60-mph headwinds that picked up where the typhoon left off. "When gales neared 100 knots, those big Chinese junks in the straits were tacking into the winds and passing us!" Truman recalled. They debated turning back to Hong Kong, but then Truman spotted a small port city, Amoy, on the map about halfway to Shanghai. He buzzed the city, then climbed back to rejoin Evans. It wasn't clear whether the residents were friendly, he reported, but he'd spotted dozens of people bicycling toward the airport. "I'm ready to land and get out of these winds," Truman said. Evans agreed.

Once their aircraft had been shut down and secured, the pilots climbed down onto the windswept field—and ran right into a language barrier. The pilots heard not one word of

Loa Truman (left) and Doris Evans relied on radio reports for the latest news of their husbands' flight.

NASM

By the time they arrived in Anchorage, the Cruisers looked worn and weary. Bad weather plagued the pilots throughout the trip, but storms in Alaska and Canada were the worst.

English until a boy about 10 years old pushed through the crowds crying, "I speak English! I speak English!" Unfortunately, those proved to be the only words of English the boy knew. Truman reached into his briefcase and fished out a letter in Chinese that had been prepared for them in Washington. He handed it to an airport official, who read it and nodded. The pair would be welcome.

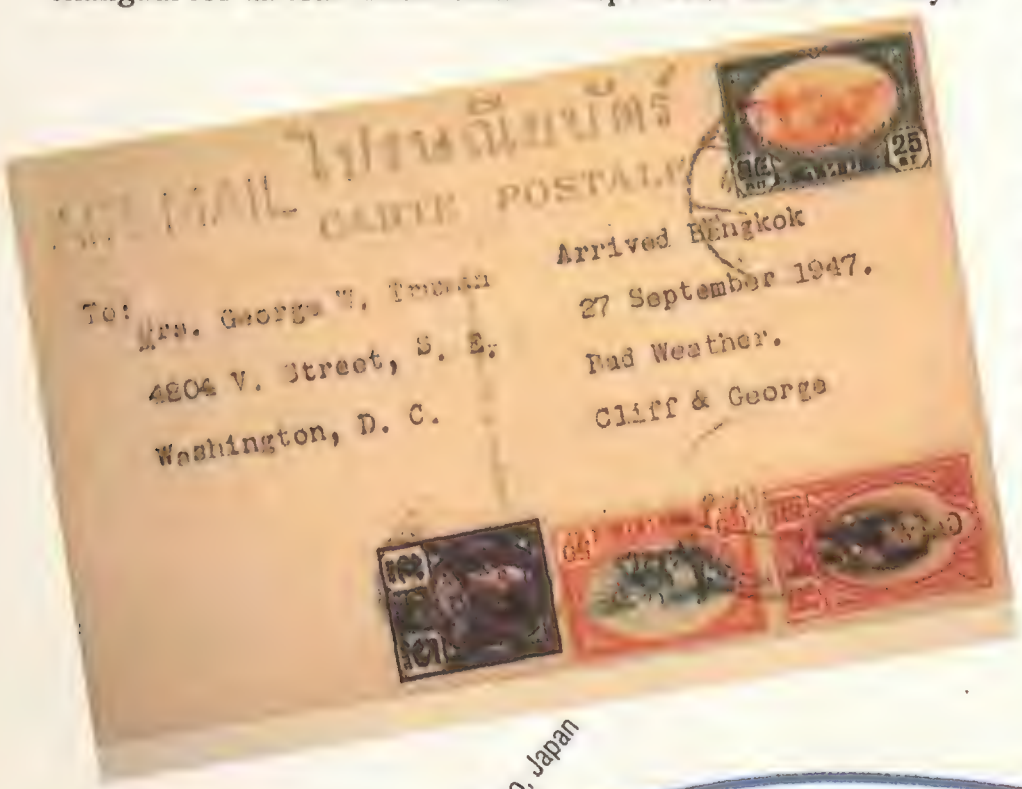
Four days later the winds subsided and the pilots flew to Shanghai for aircraft maintenance inspections and a few days with General Claire Chennault, the ex-Flying Tiger commander who was running China's Civil Air Transport after retiring from the U.S. Army Air Corps.

Shanghai was a big hit. "We were both very sorry to leave," Evans wrote in one of his regular dispatches for the Washington, D.C. *News*. "It was the most modern city we had seen up to that time, and the people treated us like visiting royalty. I think if we had stayed there a few more days we would have just settled down, gotten a job pulling rickshaws, and started life over again." (The temptation to stay must have been especially strong for Evans; Chennault offered both pilots jobs flying with his airline, and one year later Evans accepted.)

But behind the good times, a huge worry always loomed. The longest, most dangerous leg of the flight, from Japan to Alaska's Aleutian Islands, lay ahead. The pilots spent a week in Tokyo resting up for it and attempting to gain permission to fly over Soviet territory, but they didn't succeed.

On October 28 they lifted off from Nemuro, Japan's northernmost airfield, bound for Shemya Island in the Aleutians. Two U.S. Air Force B-17s flew long, lazy ovals above them, watching over the Cruisers on their 1,700-mile voyage.

The numerous delays had placed the fliers over the north Pacific in weather much colder than they had hoped for. Now weather stations were reporting icing conditions above 4,500 feet—troubling news for the Cruisers, which lacked de-icing equipment. Truman was at 4,000 feet when ice began to form



on his wings. Notifying Evans and one of the B-17s, Truman dropped the *City of the Angels* to 500 feet. When the ice melted he cautiously crept back up to altitude.

Then the *City of Washington*'s engine quit. Evans, who in the darkness could not read the fuel gauge on the wing, had run the left tank dry. "I lost another inch of hair before I remembered to switch to the other gas tank," he later told a reporter for the Washington *Times Herald.* The engine roared back to life, but not before the pilot had released an overhead life raft, opened a box of flares, and buckled on a life vest.

After more than 13 hours over water, the Cruisers touched down at Shemya Army Air Base. Now the aviators needed only fair weather to negotiate the Alaskan and Canadian coastlines. But the weather turned out to be the worst of the entire flight. It took almost four weeks to fly from the Aleutians to Los Angeles, where they finally touched down on Thanksgiving eve. They were on the home stretch.

On December 10—122 days, 23 hours, and four minutes after leaving Teterboro—the Cruisers' pilots returned to a heroes' welcome. "There are probably 10,000 pilots in the country who could do what we have done if they were careful," Truman said. "That's about all we were trying to prove."

But while the flight had demonstrated their point and earned the pilots a modicum of renown along the way, it had severely strained their finances. The new heroes tried to recoup some of their losses by displaying their famous airplanes at airshows. As a goodwill gesture, Piper Aircraft later bought back both aircraft.

In 1949 Piper presented Evans' *City of Washington* to the Smithsonian Institution. Today, its flanks festooned with painted flags from the nations it visited, it is on display in the

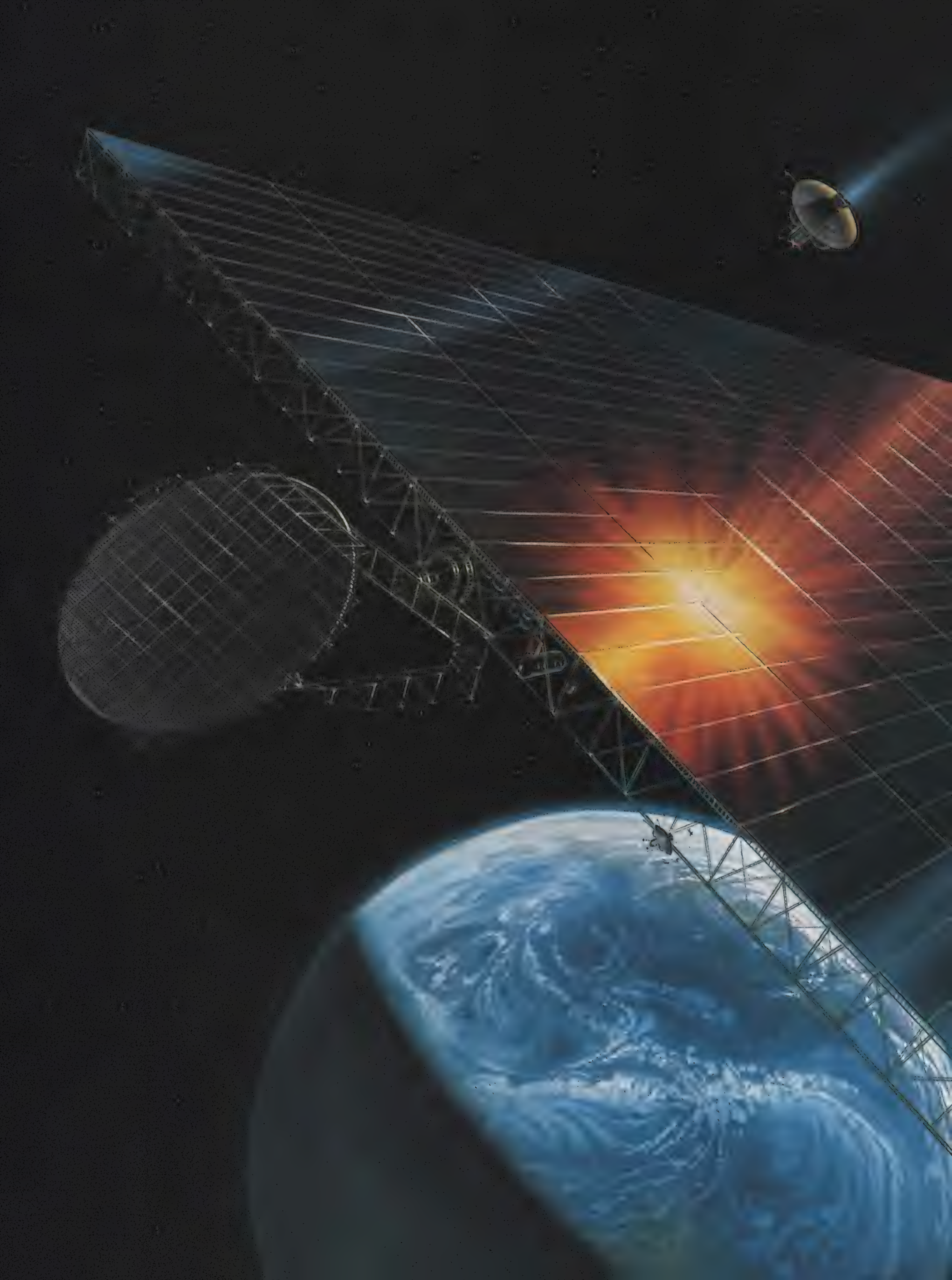
Although a dour aide warned George Truman not to claim any kinship to Harry, a postflight meeting with the president was still a thrill.

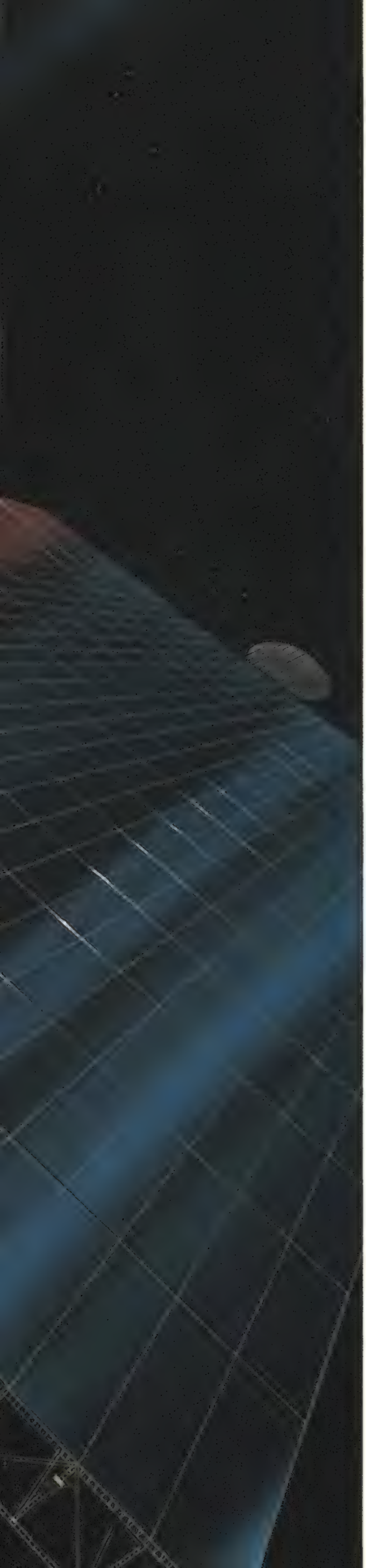
National Air and Space Museum's Garber Facility in Suitland, Maryland. William Piper held onto Truman's *City of the Angels* a little longer, flying it to airshows himself before selling it. The Super Cruiser is now being restored to its 1947 appearance at an airport in Fredericksburg, Virginia, and its owners hope that it, too, will eventually become part of a museum's collection.

Although the pilots lost touch with each other after Evans went to China to fly for Chennault, word of his death reached Truman in 1975. Truman died January 28, 1986—the same day the *Challenger* astronauts perished.

George Truman told me shortly before his death that his fondest memory of the odyssey was learning how George Brinckerhoff, the doubter, had almost become a convert. When the Cruisers landed at Shemya, word was flashed worldwide by radio. At College Park Airport, a secretary rushed the report to the operations office. "Mr. Brinckerhoff, I was told later, was thoroughly elated, but stunned, too," Truman recalled with a grin. Seated in a chair near the potbelly stove, Brinckerhoff couldn't help repeating, "It can't be done! It can't be done!"

A noteworthy imprint on the reverse side of Truman's envelope, dated December 10, 1947, marks the journey's end.





300 Billion Watts, 24 Hours a Day

Peter Glaser won't give up on his cosmic solution to the world's upcoming energy crunch.

by Linda Shiner

Illustrations by Paul DiMare

Spend some time with Peter Glaser and inevitably he will begin reciting a roll call of macroindustrial evils: fuel depletion, acid rain, overpopulation, oil spills, deforestation, nuclear waste. It's a list of demons he thought he exorcised over 20 years ago, when he first proposed a redemptive technology that would save us from our oil-burning excesses and clean our filthy air. Glaser wanted to use solar power satellites to capture energy from the sun and beam it down from space, through the night, through the clouds and the atmosphere, to power entire cities on Earth.

Glaser introduced his concept at a 1968 energy conversion engineering conference in Denver. Then he took his idea to Washington, where he learned that big ideas find big enemies. Glaser's idea, the biggest space system ever proposed, collapsed under the weight of its grandiosity. But for a number of reasons, among them Glaser's die-hard, drumbeat advocacy, the idea is still around.

In a Czech accent softened by 35 years in Cambridge, Massachusetts, Glaser, a vice president of the Arthur D. Little consulting firm, tirelessly tells his audiences—one in Houston in November 1988, another in Princeton the following May, another in Cleveland last June, and countless other gatherings since the Denver conference—that the burning of fossil fuels cannot continue to meet the energy demands of this planet. Every new energy-related ecological disaster reinforces his certainty that the U.S. government's policy for long-range energy planning is wrongheaded. "But you see Exxon has a problem now," he said after the *Valdez* dumped more than 10 million gallons of oil in Alaska's Prince William Sound. "And I say that's just the beginning of the problem." Glaser makes such predictions with a wise, unsettling smile, and in his words solar power satellites sound less like a sci-fi prop and more like a way to save the world.

Tapping the sun's power, huge orbiting grids of solar cells could provide Earth with electricity.

Salvation begins with photovoltaic cells, the same equipment that for 30 years has converted sunlight to electricity for communications satellites. In Glaser's vision, once a series of "sunsats" reach geosynchronous orbit, the cells, arranged in huge grids, are bathed in almost perpetual sunlight. Each grid is equipped with devices for converting the electricity produced by the solar cells into microwaves and transmitting them to receiving stations on Earth. The rectifying antennas, or rectennas, convert the microwaves into direct-current electricity, which is fed into the local utility's power supply (see "From Sunlight to Sockets," p. 71).

"I must tell you that my friends thought I was a science fiction writer," Glaser says of the early days. "I was talking about [solar arrays] miles in di-

ameter, solar cells which would last 30 years and could be replaced, microwave power transmission, which was obviously a pipe dream. Anyone who was any establishment member at the time would say, 'Glaser must have smoked grass.' "

"Peter was, well, was operating on another level," says Fred Morse, who last year retired from the Department of Energy after heading programs on terrestrial solar power for 13 years. In 1969, when Morse was teaching mechanical engineering at the University of Maryland, he chaired a White House panel that studied renewable energy sources—solar, wind conversion, biomass (plant matter), geothermal (underground steam)—to find out which might provide a national supply. "During that time Peter Glaser proposed his concept," he recalls. "And Peter ran into some opposition on the panel. There were a group of people who felt, 'Let's deal with the terrestrial [methods] and let's solve those because they're within our budgets, within our knowledge.' Peter had a much more long-range view.

"A lot of people said that it didn't make sense. It was like sort of not paving your country road and building a suspended superhighway [instead]," Morse says. "There wasn't opposition to it technically. There was a feeling of a sequence of things. But it fit into a continuum and it was certainly out at the long-range end of that."

Four years later long-range predictions of energy needs were abruptly skewed by a four-letter word: OPEC. Suddenly the solar power satellite didn't seem like science fiction anymore.

After the first Arab oil embargoes in 1973, Glaser made numerous trips to Washington. Congressional, NASA, and Energy Research Development Agency interest culminated in a three-year, $19.5 million program to evaluate the SPS. When ERDA became the Department of Energy in 1977, its research division opened an office to run the evaluation. Program manager Fred Koomanoff hired hundreds of scientists, engineers, and economic and systems analysts to examine the concept from nearly every angle, assessing requirements for space structures and operations, environmental and biological effects of microwave transmission, international ramifications, interference with satellite communications and astronomical studies, costs, and comparable options for producing electricity. Despite identifying 47 problems requiring additional research, the DOE/NASA report published in 1980 found that none posed a technologically insurmountable hurdle to deploying an SPS.

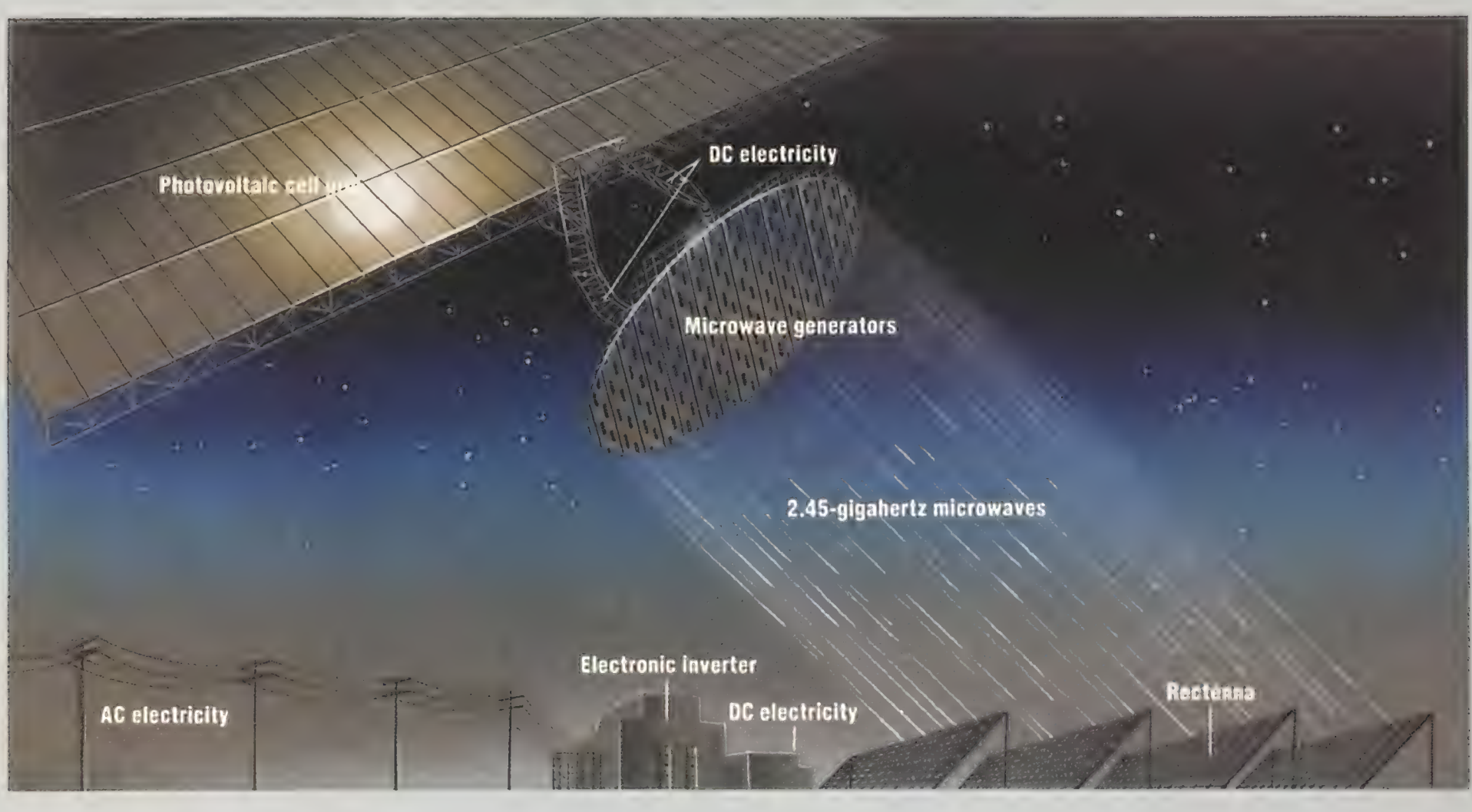
Nonetheless, opposition to SPS was intense. Astronomers objected to its potential interference with optical and radio astronomy. Environmentalists complained about the hazards of microwaves, leading wags on Capitol Hill to refer to sunsats as "bird fryers." The solar power lobby shunned the system because of its size. "You don't want to take into your family a huge voracious visitor," says Morse. "Then your kids get hungry. Peter's project had the potential to demand a lot of money."

DOE ultimately choked on the price tag: $102.5 billion over 30 years for research, demonstration, and production of the first satellite-rectenna unit and $11.5 billion for each pair thereafter, for a truly grand total of $781 billion (in 1977 dollars). The National Research Council, the operating arm of the National Academy of Sciences, issued a report in 1981 that called those figures conservative and pushed the estimate to $3 trillion over 50 years. The NRC, describing the SPS as greater in scope than the Manhattan Project, the Panama Canal, the federal highway system, or the Apollo program, found "sufficiently serious difficulties" not only to counsel against funding SPS development but to recommend that no funds be committed for 10 years.

Glaser is still vexed by the report, which he says was biased. "Essentially they said, 'Well, that's nice and there are some interesting aspects to it, but you know it costs too much. And the transportation system isn't available. And the silicon [solar cell] isn't good enough.' And I said, 'Of course it isn't. I mean, fellas, we haven't even built the

Peter Glaser's quixotic zeal for the SPS has matured into a calmer but still relentless advocacy.

SUSAN LAPIDES



From Sunlight to Sockets

In Peter Glaser's solar power system, sunlight undergoes several transformations before it provides the electricity for toasters and hair dryers on Earth. Dozens of square miles of photovoltaic cells convert sunlight to direct-current electricity, which is conducted by wires on the back of the solar array to several million microwave generators arranged in a plate-like slotted transmitter more than one-half mile in diameter.

Some engineers favor solid-state amplifiers instead of klystrons or other vacuum tube oscillators for conversion and transmission, but Raytheon's Bill Brown, one of the original designers of the transmission system, says that magnetrons, the same devices that convert electricity to microwaves in microwave ovens, are best suited to the purpose. The magnetrons would keep the microwave transmission locked precisely at the 2.45-gigahertz frequency. The transmitter would shape and point the beam to strike a 60-square-mile "rectenna"—rectifying antenna—on Earth. (Higher frequencies would enable the system designers to use a smaller receiver, but higher frequency beams are absorbed by clouds. Radiation at lower than 2.45 GHz can negotiate the atmosphere more efficiently, but microwaves of lower frequency would require even larger receivers.)

Dipoles in the receiver convert the microwave radiation back to direct-current electricity. Electronic inverters can then change the DC electricity into AC for transmission to power distribution plants. *Voila!* Burnt toast!

—Peter Fries

equivalent of a DC-3 and you're telling me that the DC-3 isn't gonna be the way that you're gonna transport thousands of people a month across the ocean .... Of course I agree. But what the hell has that got to do with building solar power satellites which will use technology of the 21st century, not of the 1960s?' "

NRC panel member Thomas Paine, a former NASA administrator who worked for Northrop at the time, defends the group's recommendation. "There was a feeling that we'd be perpetrating a hoax," he says. "We didn't want to say to the public, 'Hey, we're going to give you cheap, clean power from space.' "

The NRC report did recommend that DOE and NASA periodically review relevant technologies and report any progress to Congress. The congressional Office of Technology Assessment, after conducting a more positive evaluation, also urged further study. But by 1980 fuel prices had dropped, gas lines were memories, and the 1970s fervor for alternative energy sources waned. The SPS was axed from the federal budget. For the next decade, no sunsat research, let alone development, was funded by a U.S. agency.

Foreign competition, the threat of last resort that every scientific constituency wields when government grows stingy, frequently arises in discussions of solar power satellites. "If this is a successful system and someone else does it, it's going to represent an enormous loss of income," warns one SPS supporter. The Soviet Union, West Germany, France, and Japan have announced plans to develop solar power satellite systems, but only Japan has worked out a specific plan and begun to implement it.

"Solar cells will reach their cost goals," says Morse. "It's just a question of doing the research and hoping, hoping, hoping that they'll be American and not Japanese or German."

Of course, U.S. research in power transmission and photovoltaics didn't die with the SPS. In the past decade relevant technologies have gotten a powerful leg up from another trillion-dollar space dream, the Strategic Defense Initiative. Laser technology, as suitable for transmitting power as it is for vaporizing somebody else's stuff, is

only the most publicized beneficiary. The SDI Organization is spending millions on solar cell materials research alone.

"We know a lot more about power distribution," says Jerry Grey, chairman of the International Astronautical Federation space power committee. "We know a lot about high-power microwaves that we didn't know then, but that's mainly from military programs, where they're designed for damage. Still, there's a technology fallout" (see "The Solar Cell Sandwich," p. 74).

The only U.S. research aimed squarely at solar power satellites in the past decade has been sponsored by the Space Studies Institute, which has focused on the first threat to any serious consideration of the SPS: the overwhelming difficulty of getting that much mass and weight to orbit. Lifting the material for one 55,000-ton satellite to even low Earth orbit would require 550 launches on the rocket currently holding the record for payload capacity, the Soviet Energia. Even state-of-the-art solar cells and gossamer structures can't slim the satellites enough to make the launch costs reasonable.

Unless the launch starts elsewhere.

"In terms of just raw energy, it's 22 times easier to throw something off the moon than the Earth," says SSI executive Gregg Maryniak. "And that's without [considering the effects of] atmosphere—Earth's atmosphere makes it harder." The institute wants to build the satellites from material mined on the moon—aluminum, silicon, oxygen, and iron—and Glaser agrees that this would be the sensible way to proceed.

Maryniak admits that launch costs are then replaced by the expense of building a spartan lunar base and processing plant. But politically and scientifically, it would be easier to develop a crude manufacturing infrastructure on the moon than a fleet of cheap launch vehicles operating with the frequency required to loft an SPS system.

Even if the moon's bounty can relieve the cost of sending solar arrays into orbit, grave questions remain about sending the energy back down to Earth. Microwaves are spooky. Though they do not penetrate animal tissue with enough energy to ionize molecules, as do X-rays and gamma rays, they do penetrate to a degree, agitating and thereby heating molecules.

The scant research into the effects of microwave radiation on human beings has produced wildly divergent results—and consequently a wide range of safety standards. The Soviets have the most stringent rules on occupational exposure: they allow only 0.01 milliwatt per square centimeter. U.S. regulations are far more lenient, allowing up to 10 milliwatts. The concentration of energy at the edge of an SPS rectenna would fall between these limits—about one milliwatt per square centimeter. Glaser points out that the Food and Drug Administration permits five times that level at the edge of microwave oven doors. Nevertheless, environmental and biological effects of microwave radiation are two areas where Glaser says research money should be spent.

Have the relevant technologies advanced enough to justify another look at sunsats? The National Research Council says no. Last October Eugene E. Covert, the vice chairman of the NRC aeronautics and space engineering board, declined Glaser's suggestion that the council reopen the evaluation.

But Jerry Grey, who was chairman of the Office of Technology Assessment solar advisory panel for seven years and a member of the 1981 OTA study group that had cautiously recommended further study of the SPS, thinks it's time to reconsider. "We're about to begin the development of a major space infrastructure for the human exploration initiative," he says. "NASA is going to go ahead in some form or another . . . . It's in the '91 budget. And you know it's a 30-year time frame, but that's okay, so's the SPS.

"Part of the human exploration initiative is mining and manufacturing materials on the moon," Grey continues. "That's necessary to go to Mars. It's also necessary for a satellite power system. So there are a lot of efforts that will be compatible and supportive of a satellite power system that are going to get done anyway and will not be charge-

In an updated SPS scheme, solar arrays would be placed on an orbital platform already in place—the moon.

able to the satellite power system."

But human exploration is a space agency initiative. A space power system is an energy agency concern. And the Department of Energy currently has no interest in a solar power satellite. Some people say it never has—that its sights were always set on an entirely different but equally recalcitrant technology.

Fred Morse says, "DOE never considered Peter Glaser's idea anywhere near the importance of the fusion program. Ever. Not in the same sentence or the same paragraph or the same book. There's some powerful lobbying capability there. Princeton, Stanford."

"The opposition of the fusion community was the last straw," says Glaser, "and essentially the whole physics community wanted to bury this. Well, they succeeded."

Nuclear fusion, the merging of two atomic nuclei into one by compressing a plasma, usually under extreme temperatures and pressures, has the potential to release vast amounts of energy. It has also consumed vast amounts of money. In the late 1970s the DOE spent $500 million a year on fusion research. At that time high-energy physicists expected a good return on the investment, but the technology has proved far more unruly than predicted, and even the physicists are admitting that it will be well into the next century before a commercial reactor can be built. One SPS advocate described a T-shirt being worn at Princeton University, the site of a preeminent fusion research laboratory, that reads "Fusion is the power of the future. And it always will be." Nonetheless, the DOE is still spending half a billion annually, and when energy secretary James D. Watkins presents President Bush with the nation's first comprehensive energy strategy this September, fusion will play a part in it. Solar power satellites will not.

Even NASA has indicated only the tiniest interest in renewing work on space-based energy systems. But last July a report from the agency's office of exploration revealed that a few people in NASA are still thinking about sunsats. The report came from the Lunar Energy Enterprise task force, which was charged with investigating the feasibility of mining the fusion-friendly helium-3 isotope on the moon and transporting it to Earth for use in fusion reactors. To place this scheme in a context for comparison, the group considered Glaser's plan as well as a new approach conceived by David Criswell, a space physicist and lunar resources specialist at the University of California in San Diego. "I was just out of college when I read Glaser's first article in *Science*," says Criswell, "and I was just awestruck by it. I still am. I mean, the guy's a real

CHAD SLATTERY

A creator of the lunar platform plan, David Criswell was inspired by Glaser's sunsats early in his career.

The Solar Cell Sandwich

The photovoltaic solar cell was first used in a spacecraft in 1958, powering the U.S. satellite Vanguard 1. The cell is a simple but elegant device that converts light into electricity. The design in widespread use today consists of two layers: one of phosphorus-doped silicon, the negative or N-layer, and the other a wafer of boron-doped silicon—the positive or P-layer. (In both cases, the "doping" element is a measured impurity diffused through otherwise pure crystal.) The junction of the two layers forms an electrical field.

When photons of light are absorbed by the silicon atoms, they knock loose negatively charged electrons, which migrate to the N-layer. The positively charged electron "holes" created by the dislodged electrons migrate to the P-layer. This migration across the junction produces direct-current (DC) electricity, which flows along wires that connect the metal grid atop one cell's N-layer to the metal-coated P-layer of its neighbor.

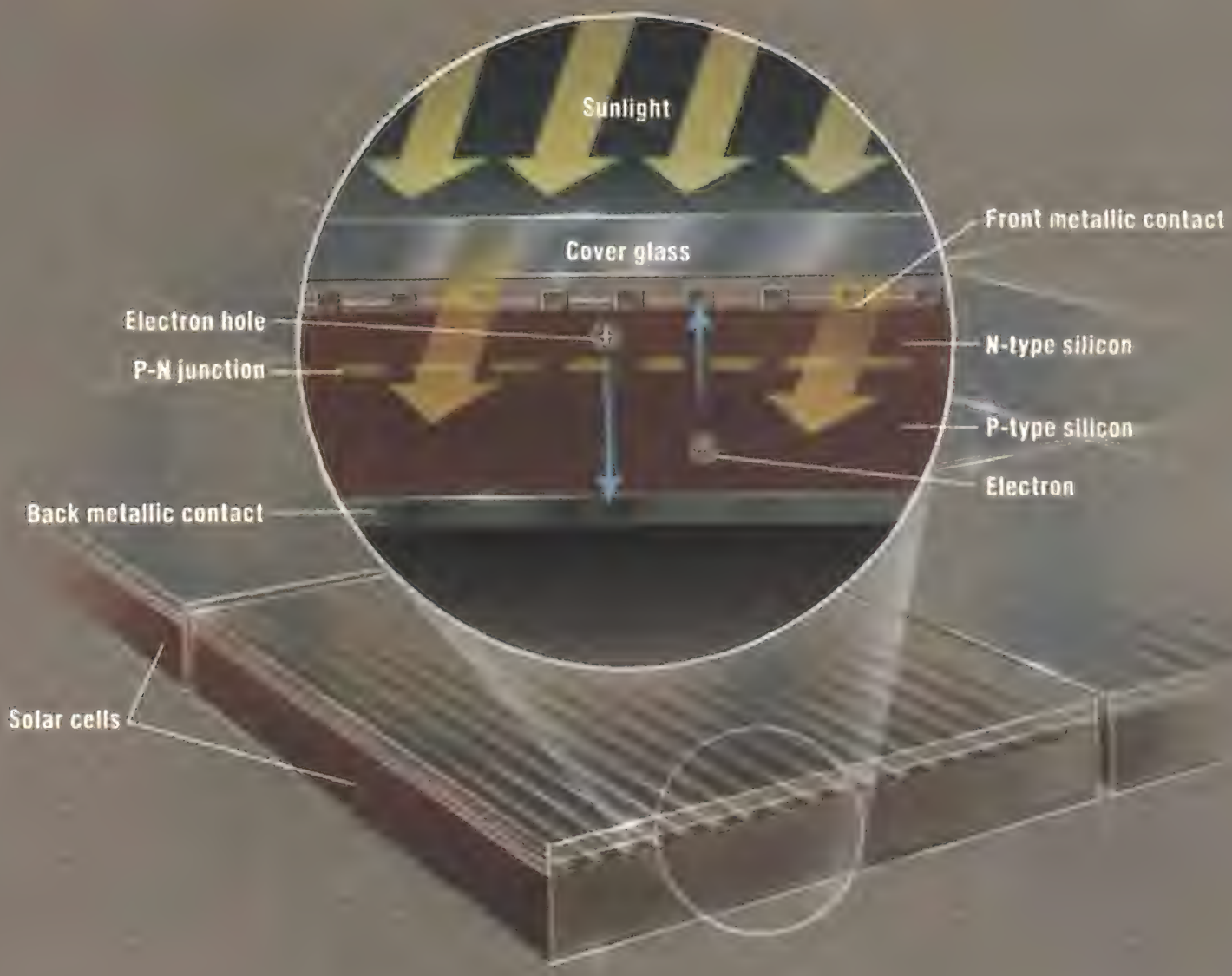
Because silicon can absorb only a small portion of the solar spectrum, the cells' efficiency rate—the amount of solar energy that is converted into electricity—is roughly 15 percent.

One of the most promising cells under development is the tandem or multi-junction cell, which stacks together different semiconductors that absorb wavelengths at the high and low ends of the solar spectrum. Silicon responds to longer wavelengths; gallium arsenide, for example, responds to shorter wavelengths. Silicon-gallium arsenide and germanium-gallium arsenide sandwiches have nearly doubled solar cell efficiency. A gallium arsenide-gallium antimonide cell recently achieved a record efficiency rate of more than 31 percent.

Researchers are further increasing efficiency by placing concentrators consisting of Fresnel lenses or mirrors above the cells. The resultant weight increase of the solar array is compensated by the use of fewer and smaller cells.

Despite laboratory advances, the single-crystal silicon cell, recently boosted to 22 percent efficiency with the use of concentrators, will be the workhorse of the U.S. space station's extensive solar arrays. It's easier to manufacture, has a lower technical risk, and, most important, is cheaper than its multi-crystal offspring. Initially, the station will need 75 kilowatts of continuous capacity—about the amount used by 30 terrestrial homes and five times the requirement of Skylab.

—Peter Fries



genius to be that far out in front and be able to orchestrate and push and get a national effort going."

Criswell's idea is similar to the SPS, but he wants to eliminate the step of building a large platform for the solar arrays. The moon, says Criswell, is a stable enough platform, and it's already in place.

Ultimately, the task force concluded that the moon will play a major role in terrestrial electricity supply. The report did not endorse either solar power concept or the mining of lunar He-3; rather, it recommended that yet another group be created to mesh the goals and expertise of all the disparate bodies that would contribute to a space energy policy. That includes NASA, DOE, the Environmental Protection Agency, Congress, the National Space Council, universities, and private industry.

Anyone who worked on the solar power satellite program in the 1970s is accustomed to contemplating large numbers: 300 billion watts of electricity on tap around the clock, generated by 60 satellites constructed over 30 years by 20,000 astronauts.

The SPS is a very big solution to a very big problem. "In 3,600 days, which isn't very long, we're going to add to this world one billion human beings," says Koomanoff. "Now these numbers blow your mind. But they're people."

In 1985 the peak demand for electricity in the United States alone rose to 461 billion watts, far surpassing the magic number Glaser's sunsats would provide. In under 50 years that figure will double, according to the Organization for Economic Cooperation and Development, and not only for the United States. The OECD predicts that all of North America, Western Europe, and the industrialized Pacific will require twice as much electricity by 2030. Developing countries will want eight times what they used in 1985.

Even so, almost all long-range energy forecasts show supply holding its own against demand well into the next century. But starting around 2030 the world will need a new energy source. In the meantime, another number comes into play: five billion tons of carbon dioxide being released into the atmosphere every year by the combustion of coal and oil.

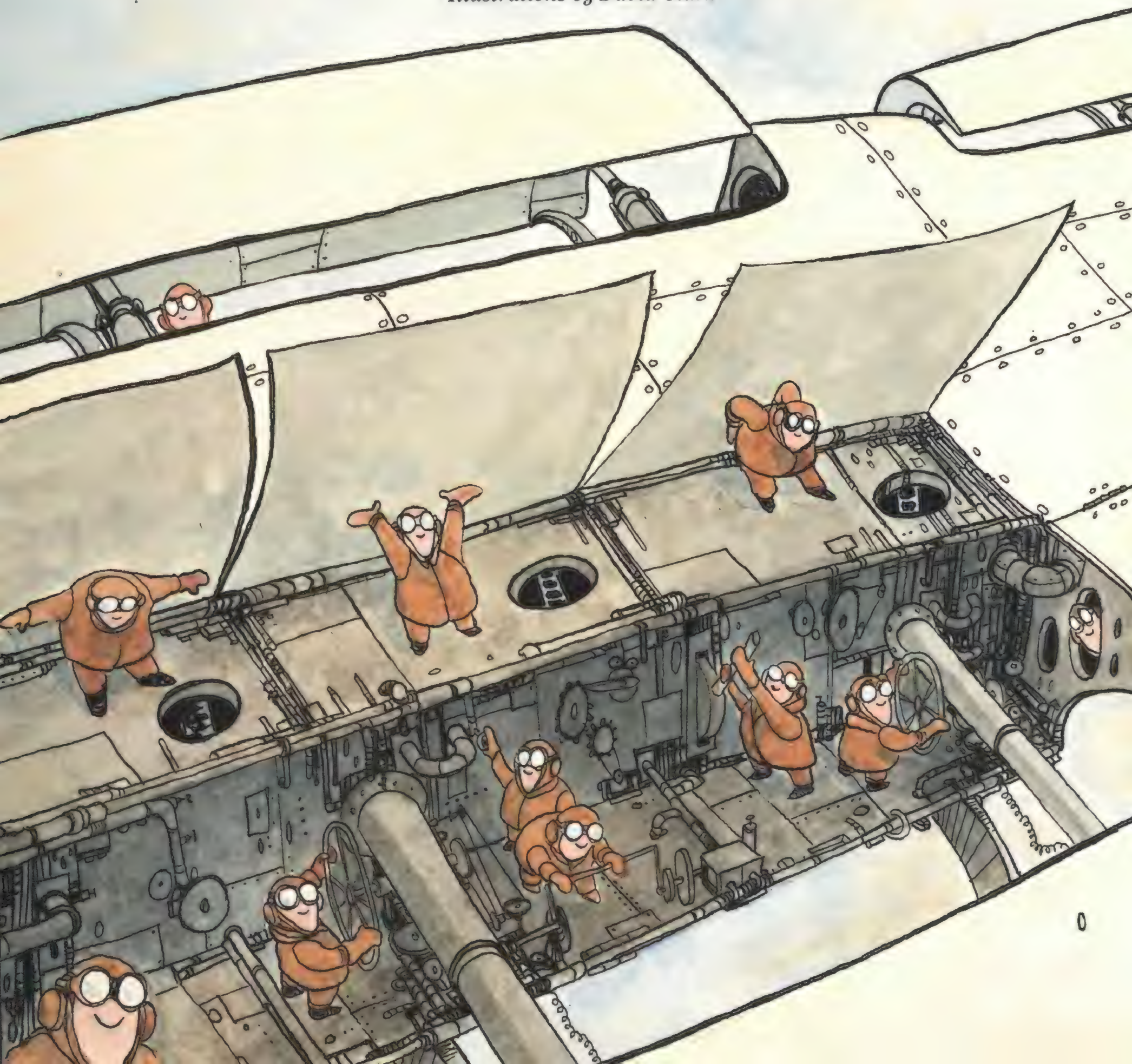
"What happens to a dream deferred?" wrote Langston Hughes in the poem entitled "Harlem." "Does it dry up like a raisin in the sun? Or fester like a sore . . . ?" In April Glaser joined a handful of SPS program alumni at a reunion in McLean, Virginia, to talk about what happened to the dream. They went "to reminisce on past glories," said one organizer, "and bewail the current state of affairs." No doubt they complained about the inability of the United States to commit to a long-range plan the way Japan does. "If you don't do it we'll become a backwater in history," Glaser once said, smiling wisely. "You know England was a leader in the world for how many years? Today? It can happen here."

Next April Glaser will be in Paris for an international symposium on power from space, organized by the director of the French national utility Electricité de France to promote research and interest in the SPS concept. There he will deliver a message as reliable and consistent, if not as bright, as the sunrise. ←

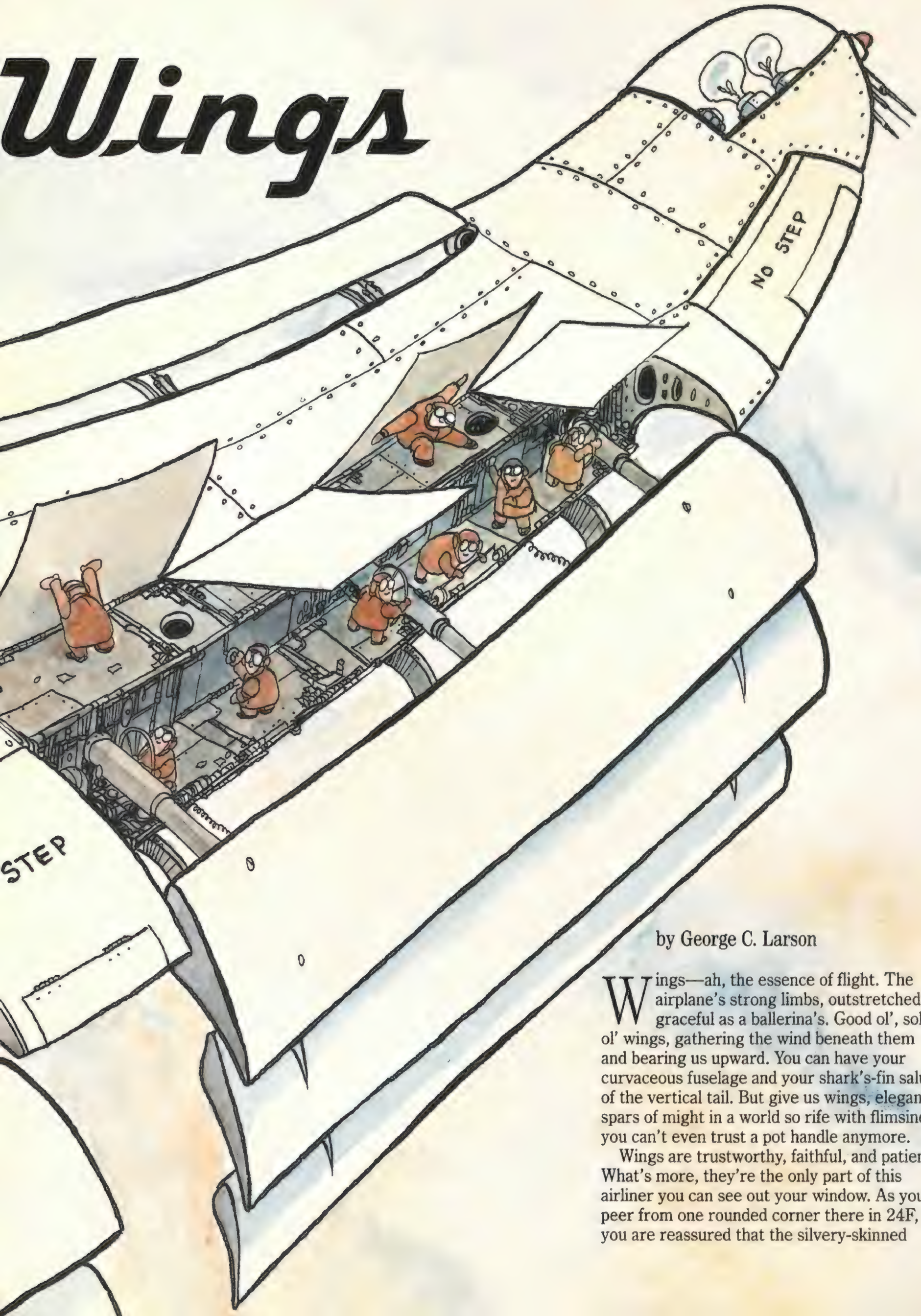
Things In

(The ones that flip up,
reach down,
and go bump in the flight.)

Illustrations by David Clark



Wings



by George C. Larson

Wings—ah, the essence of flight. The airplane's strong limbs, outstretched, graceful as a ballerina's. Good ol', solid ol' wings, gathering the wind beneath them and bearing us upward. You can have your curvaceous fuselage and your shark's-fin salute of the vertical tail. But give us wings, elegant spars of might in a world so rife with flimsiness you can't even trust a pot handle anymore.

Wings are trustworthy, faithful, and patient. What's more, they're the only part of this airliner you can see out your window. As you peer from one rounded corner there in 24F, you are reassured that the silvery-skinned

wings are ready to endure the firmament's hammers upon their willing expanse, their aluminum continuum, a continuum with seams.

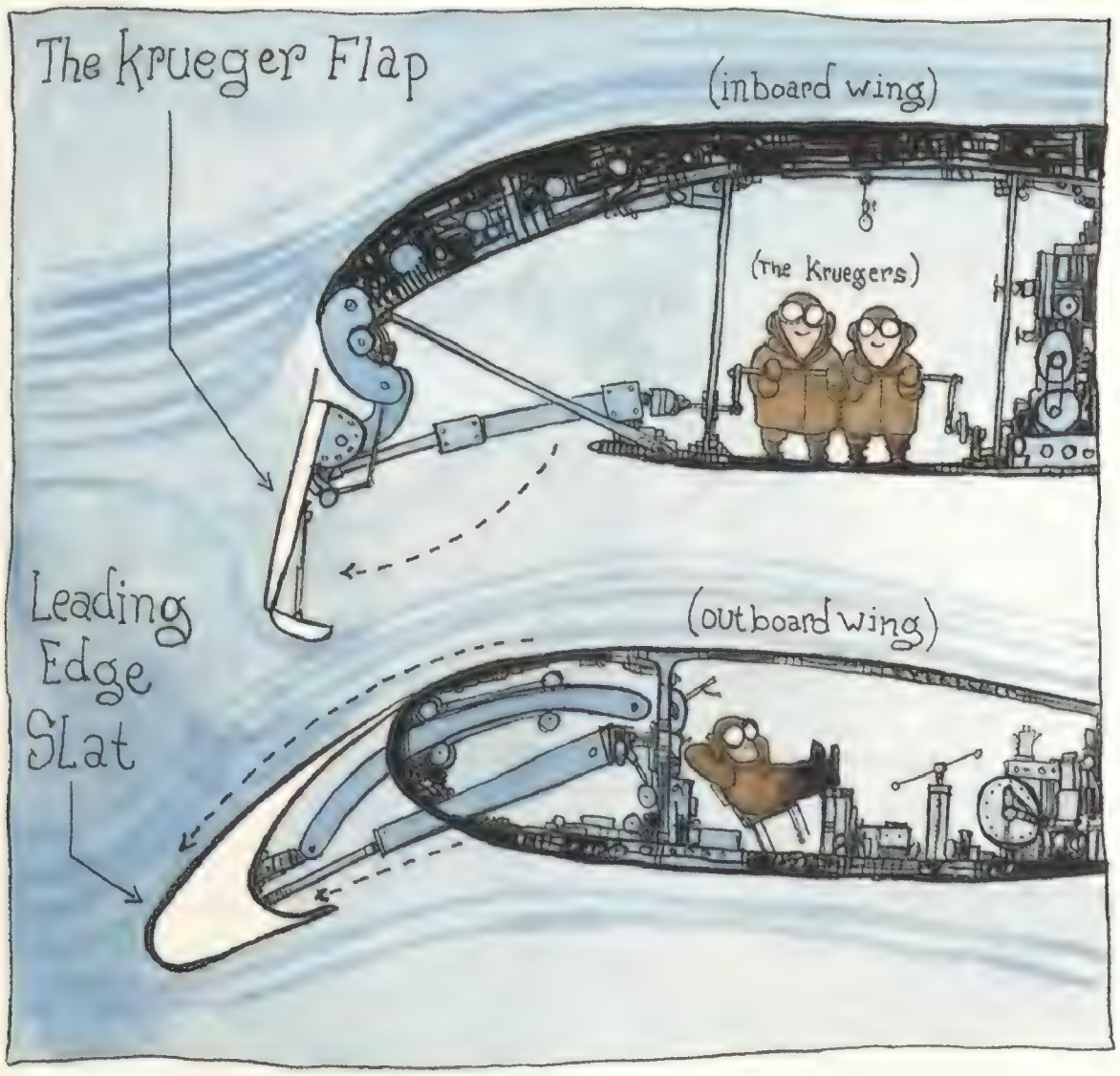
With seams?

Yes, you notice that among the rows of rivets and fasteners, the continuum does have a few seams in it. In fact, one of the seams is, even now, widening somewhat. No—more than somewhat. It's no seam anymore. It's becoming a crack, now a rift, and—saints preserve us—you can see the ground through what is now, no question about it, a gap! And more chunks are in motion, entire continents adrift on the map of the wing as one huge section starts moving aft while some pieces in the middle flap up and down like long johns on a clothesline. Alert the flight crew!

Various surfaces enable the wing to adapt to extreme variations in speed.

But not yet. Everyone around you seems calm enough. Not one to make a scene, you determine that before you pull the emergency cord or whatever it is that will bring this airliner to a stop right here on the taxiway, you will study the situation. For one thing, all the motion out there on the wing certainly appears purposeful. Motors whine in concert with the motions of the panels, and you notice that what moves up moves back down again, returning to its apparent proper nesting place.

Had you stormed the cockpit to report wing trouble, the crew would have explained (as you were cuffed and led away, no doubt) that the activity out there on the airliner's wing is not dangerous. It is a perfectly normal exercising of all the specialized parts that enable this airplane to accomplish the seeming miracle of cruising at a speed close to the velocity at which sound travels and then slowing to land at about one-fifth that speed. The flight crew may have alarmed you by exciting all that hydraulically actuated sheet metal, but what you've witnessed has been the crew's normal before-takeoff check of the various surfaces that enable the wing to change its shape in order to control the airplane and adapt to the extreme variations in speed you are about to experience.

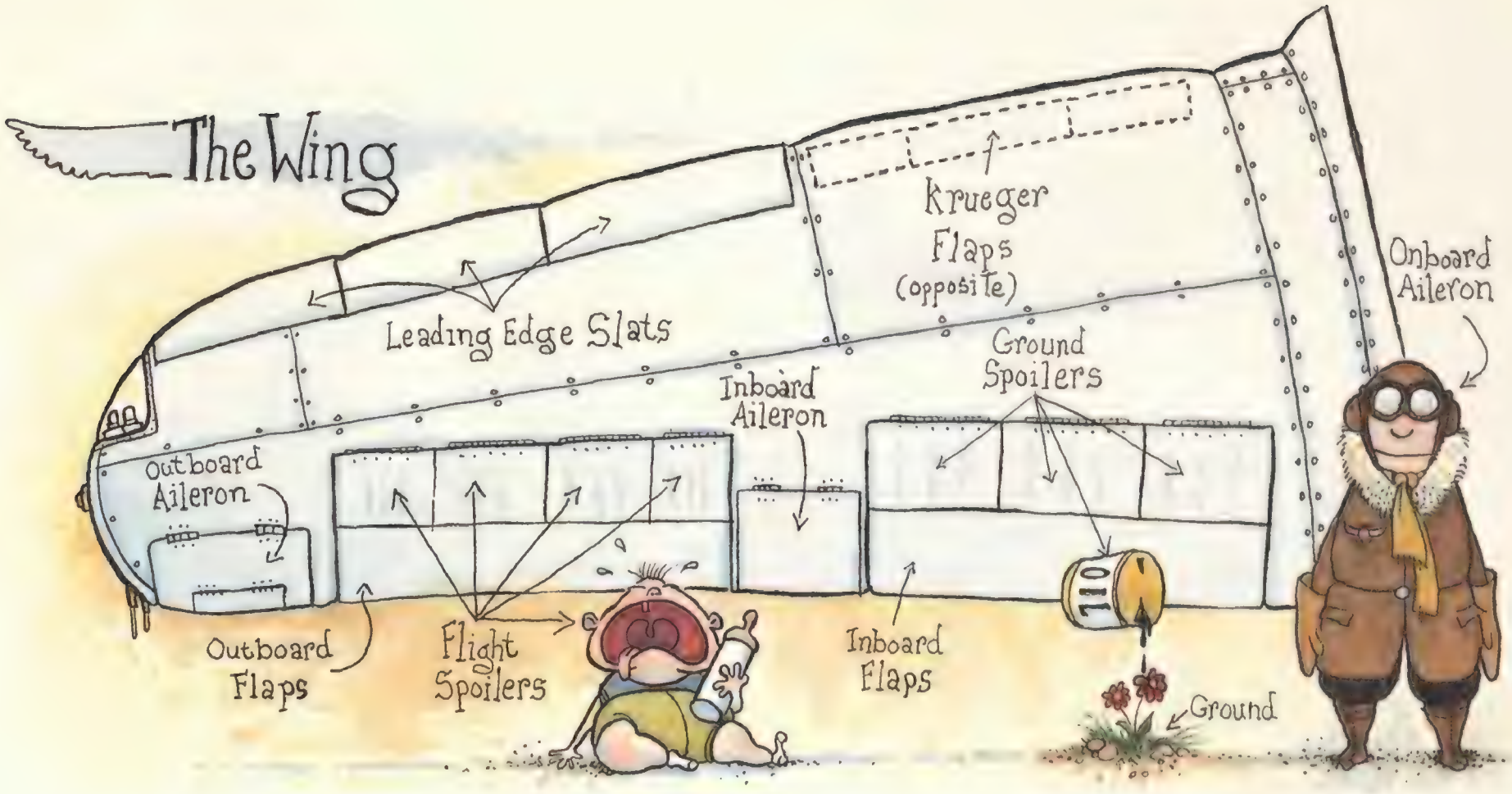


Wings were not always so complex, but then airplanes did not always fly so fast. They must still retain the ability to fly slow for the simple reason that the most valuable commodity in air travel is an airport, a fact that anyone in the real estate business will immediately grasp. Were an airliner unable to fly slow and still maintain normal flight control, it would need a runway the length of Tennessee and a set of brakes the size of the Pentagon just for the simple act of landing.

Steering the airplane to the right place for landing depends on one of the most important moving parts on a wing—the aileron. The Wright brothers used a technique called "wing warping," in which they twisted the entire box truss wing of their biplane in order to effect changes in lift on the left and right sides, thereby rolling the airplane to the left and right and providing directional control. But the Wrights' wing was all one piece. Glenn Curtiss made use of a second piece—a moving panel on his biplane's wing—so the wing no longer had to be warped to make the airplane turn. By using his ailerons to deflect the passing wind in flight, Curtiss obtained very effective roll control.

On modern jet transports, the aileron may be one surface or several. It's easy to spot an aileron from your window: it's the surface on the rear (trailing) edge of the wing that moves in response to the airplane's rolling motion. After the captain announces that you've reached cruise altitude, observe the wing while the airplane seems to be on course and flying straight. Inevitably, the wingtip will rise or dip with respect to the horizon. If it rises, an aileron will flex upward gently, thereby deflecting passing air upward and forcing the wing back down, rolling the airplane back to level flight. That's its job.

Ailerons are located out near the wingtip, but there may be a second set farther inboard, closer to where you're sitting. The



arrangement varies with airplane type, but in general the inboard ailerons are more important at higher speeds, while the ones near the tips take over more of the roll control at low speeds. The rationale for this has to do with wing structure.

At high speeds, a force developed by a control surface near the tip of the wing can more easily cause the wing to bend in response. This "aeroelasticity" is a design problem for the engineer, and it can be solved in part by a system that reduces the authority of the outboard ailerons at higher speeds and activates inboard ailerons. The inboard set can't make the wing bend as much because they don't have as long a lever arm, and they're also located on a fatter, stiffer part of the wing closer to its root. When the airplane slows, the inboard ailerons lack sufficient authority to give the captain the sort of snappy roll response that'll be needed in, say, gusty winds. So at slower speeds, the outboard ailerons come into play more.

Lockheed went one step farther with the ailerons on certain models of its L-1011 Tristar jumbo jet. It equipped these airplanes with "active ailerons" driven by a sensor and computer system that anticipate when a gust of wind would cause the wings to flex. All wings have to be built strong enough to bear the weight of the airplane in extremely sharp wind gusts that cause the wings to flex, and the ability to tolerate such punishment places a limit on the weight the airplane can carry. Lockheed wanted to increase the L-1011's load carrying ability without increasing the strength, and therefore the weight, of the wings. So the company designed ailerons that would automatically counteract the wing's flexing. Sensing a vertical gust of wind that would cause the wing to flex upward, the active ailerons near the wingtips respond by tipping upward themselves, reducing the bending moment on the wing and "unloading" it. The wing does not flex as much; therefore, it can be made less stiff and heavy.

Moving inboard along the trailing edge from the ailerons, you'll encounter the flaps. Flaps on most jet airliners are quite complex, and among all the surfaces in the wing, they play the most important role in adapting the shape of the wing to low-speed flight. You'll notice that the flaps are used when the airliner takes off and that after takeoff they are retracted into the wing. Just before landing they come back out again, and just prior to touching down on the runway they deploy in all their glory. Landings bring out the exhibitionist in an airplane. Every square inch of flap will be extended from the trailing edge of the wing to grab as much air as possible, both to help slow the airplane and to maintain the wing's lift all the way down to its landing speed.

Flaps accomplish two important jobs: they increase the wing's area and its apparent curvature, or "camber." The increase in both these values boosts the total lift available from the wing. How crucial this additional lift is at low speeds was tragically demonstrated at Detroit Metropolitan Airport on August 16,

Wings were not always so complex, but then airplanes did not always fly so fast.

1987. The pilot of Northwest Airlines flight 255 failed to deploy the flaps on his McDonnell Douglas DC-9 and crashed on takeoff, killing all but one of the 157 people on board.

So why not keep the flaps out there working all the time? After all, lift is what wings are all about. The trouble is that flaps also create drag, and when the airplane is expected to gain speed, there must be a way to get rid of the flaps. They retract into a recess in the trailing edge of the wing. Now the wing is shaped perfectly for high-speed flight. Because the air passes by at a higher speed, the wing can generate adequate lift without the additional area provided by the flaps. This "clean" wing has less drag than one with flaps deployed.

Flaps come in all shapes and sizes, but the most efficient at producing increased area and lift are "slotted" flaps that look like small wings themselves, and this type is used most often on airliners. Driven by rotating screw jacks or hydraulic actuators, the flaps move out of their stowed position along tracks in the wing structure. Generally these tracks are designed so that the flap sections first move straight back, then downward. The pilot extends the flap by increments with a switch in the cockpit. As the airplane descends to land, you may hear the sound of a motor as the pilot nudges the flaps out a small amount—just enough to increase the wing's area.

Just before landing, flaps deploy in all their glory.

As the airplane continues to slow, the pilot will deploy an additional area of flaps. The entire flap assembly will continue to move aft and downward on its tracks until the individual parts begin to separate enough so you can see two or even three sections that resemble small wings, with openings, or slots, between them. You'll also notice that, progressing from front to back, the sections of flap are curved downward at an increasing angle, so that the air is gently bent in its course until, at the trailing edge of the flaps, it flows downward. The wing may be moving more slowly through the air, but it performs more work in turning the air, thereby obtaining the required lift from it.

Just ahead of the flaps and ailerons, about midway from the leading edge to trailing edge on the upper surface of the wing, are some panels hinged at their forward edges where they attach to the wing. While your flight was taxiing out for takeoff, you noticed these being exercised, and they were flipping up and down like trapdoors. Variations of these surfaces abound on airliners, and they may function in two ways: as "spoilers" and as speed brakes—and sometimes as both.

A "spoiler" is any surface that acts to "spoil"—or interrupt—airflow. Spoilers on the upper surface of wings reduce the lift of the wing when they rise and cause the air to be separated from the wing's upper surface. If the spoilers on the left wing are activated, they reduce lift on the left wing and make the airplane roll to the left. Spoilers can be used in this way to assist the ailerons in roll control, usually at lower speed. Spoilers located at the point where the air from under the wing flows into the slotted flap system are able to act as a kind of air valve, and by regulating the flow of air to the powerful flaps, they can vary the lift the flaps generate, thereby producing a very strong force to control roll. As they open upward to spoil airflow over the upper wing, they also vent the air flowing to the flaps, reducing airflow over them and reducing lift. The sum of both effects is strong.

The spoilers on both wings may be activated equally and simultaneously to destroy some of the lift from both wings and help the airplane descend. Usually spoilers used in this way generate a lot of noise that can be heard in the cabin, but they enable the airplane to descend quite rapidly without increasing its speed too much. (Pilots are required to observe certain

The Wing With the Works

One of the most dissembling wings on an airliner was a product of market forces as much as aerodynamic ones. According to its chief designer Jack Steiner, the medium-range Boeing 727 was created in the late 1950s to attract customers by reducing their operating costs. As the airlines knew, saving time in the air would mean saving money.

So Steiner began to configure a scaled-down version of the 707, one with three engines. (He says that TWA wanted four engines and Eastern wanted two, and that's how he came up with three.) To save time in the air, he needed an airplane with high climb and descent rates and very high (Mach .8) cruise speeds. Most important, he needed the ability to land on runways roughly 5,000 feet long because Eastern, an important customer, depended on La Guardia's runway 4-22, at the time only 4,860 feet. High cruise speed demanded a small, swept, thin wing built for speed. But the short runway requirement meant that same wing would have to keep the aircraft flying as it crossed the landing threshold at only 125 mph, Boeing's design goal. This landing speed was well below that of the contemporary straight-wing turboprop competition, such as the Lockheed Electra and the British Vickers Viscount.

The answer to Steiner's dilemma was a wing the likes of which the world had never seen: it looked almost too small for the airplane, and it was swept at an angle of more than 32 degrees. Yet when it came time to slow for landing, this little wing sprouted surface area like a horny peacock. Gerry Bowes and the gang down in aerodynamics gave the 727 triple-slotted trailing edge flaps, which, when fully deployed (the complete cycle took almost 30 seconds), angled 40 degrees downward from the wing and produced a flap with a chord length 150 percent greater than its length when stowed.

Trailing edge flaps alone would have produced uncomfortably high approach angles, with the airplane's nose too high, so Boeing added some leading edge devices of wondrous complexity and sophistication. Outboard, the wing had enormous slats, complemented inboard by Krueger flaps. When extended, these look like a huge section of skin underneath the wing has been pulled down and folded forward on a hinge. The combination allowed the 727 to land fully 17 mph slower than a 707.

Shortly after its introduction, Boeing took the 727 on a world tour to stir up sales. When the airplane rolled out in about 1,500 feet during a landing in Miami, one controller was quoted as radioing, "Okay, buster, now let's see you make it sit up."

speed limits at times, particularly at lower altitude.)

And after the airplane touches down for landing and starts its rollout, the spoilers perform their final act—as air brakes. The pilot deploys them to their full upright position, dumping all the lift from the wings and producing a huge area that increases drag and slows the airplane to a stop. If your window seat is behind the wing, you can peer into the innards of the wing itself and see much of the flap mechanism when the speed brakes pop up on landing.

Even the wing's leading edge has some moving parts. Slats, slots, Krueger flaps—all manner of devices have been used to modify the shape of the wing where it first meets the oncoming air. Leading edge devices help to increase the camber of the wing, forcing the air to follow a longer curve in its course above and below the wing. On the McDonnell Douglas DC-9 family, the entire leading edge of the wing moves forward and down, forming a slot through which high-pressure air from the wing's undersurface shoots and helps smooth flow over the upper surface. That's one of the simpler examples. The Boeing 747 has a complicated leading edge device that unfolds like an umbrella to form a curved lip that extends the leading edge of the wing forward and down. Some airliners use a combination of slats outboard and flatter, less powerful Krueger flaps inboard. In every case, the effect of the leading edge device is to move the point at which air meeting the wing divides into the portion that will flow over the wing's upper surface and the portion that will pass below. And the object of the design is always to herd more of the air up over the top.

Leading edge devices are like flaps in that they are deployed only at low speeds to increase the wing's lift. They will always be extended prior to takeoff and then retracted after the airplane has gained altitude and speed. They are also extended early in the flap extension cycle in order to create the best possible camber for the wing when the airplane descends for landing. Leading edge devices also create air noise that can be heard in the cabin, but they're usually not as loud as the spoilers.

On humid days, the various air passages around, over, and under the wing can torture the air to the point where it gives up its stored water vapor in a glorious streaming trail of cloud. Watch the outboard end of the flap on a DC-9 for a beautiful vortex of steam. On Boeing 727s and 737s, the vapor can explode intermittently as huge free sheets of cloud or attach to the ends of flaps as on a DC-9.

So wings are hardly the simple slabs they appear to be. Inside, they're as alive as an ant farm, with hydraulics and motors and enough moving parts to put a bottling plant to shame. Get it all in motion and working hard and the wing can put on quite a show, complete with sound effects. And to enjoy it, you won't even need those silly plastic ear tongs.

After the airplane touches down, the spoilers perform their final act.

The first women to serve as U.S. military pilots are forever bonded by the experiences they shared.

RETURN OF THE WASPs

COURTESY ANNE NOGGLE

Like their male counterparts, WASPs trained in the AT-6.

Story and portraits by Anne Noggle

In 1943 the Women Airforce Service Pilots squadron was created by merging two groups of female pilots, the Women's Auxiliary Ferrying Squadron—WAFS—and the Women's Flying Training Detachment, or WFTD. In 1986 the WASPs held a reunion at their former training base, and Anne Noggle, a member of WASP class 44-1, took the photographs and wrote the text excerpted here from the book For God, Country, and the Thrill of It, *published this spring by Texas A&M University Press.*

I am standing here in Sweetwater, here on what was Avenger Field, here in the wishing well where I was tossed after I soloed 45 years ago, here physically in my own footsteps with the same sky above, the wind still quick and shifting, the sound of airplanes still here, though with smaller, tighter voices—and yet there is this wrenching in my chest as I fill with remembrance. I try to leave the here and now and make that one journey it is impossible to make—to live it again, not just to relive it. I have returned with my classmates and we collect on the ramp and have our picture taken—we, smiling at one another in the grace of our friendship, in the ease of our comradeship, knowing our courage but never speaking of it, bonded beyond belief. The class of 44-1. That is how we were known then; that is our mutual identity.

We gathered, my class, in the summer of '43 at Avenger Field in a mishmash of bright summer clothing with our suitcases and a sense of adventure. We were marched, in sandals or high heels, to our newly assigned quarters—six to a bay with a latrine between bays, each trainee given a GI cot and a locker for clothes. We were issued men's olive-drab GI coveralls, flight helmet, goggles, a leather

Author-photographer ANNE NOGGLE *at the WASPs' 1986 reunion (above) and as a trainee in 1943 (right).*

flying jacket, and, in the winter, fleece-lined leather pants, jacket, helmet, and flying boots. For dress we were to wear khaki pants and a plain white shirt and a khaki overseas cap. Added to that was an E6B computer for navigation and a stack of books to study for ground school.

For those six months in training we were all as one—eating, studying, flying, and sleeping all in lock step, even thinking similar thoughts, since we were deprived of private time in which to ruminate on our own outside worlds. So in this artificial, intense, closely prescribed, off-limits airfield, smack in the middle of West Texas, we coalesced and lived to fly. If I were to describe our attitude at that time with one word, it would have to be *determined,* to be good enough. To earn our wings.

After graduation I was sent to Eagle Pass Army Airfield, where I was assigned to the P-40 Gunnery Squadron as a tow pilot for aerial gunnery. When I first arrived at the field, right on the Mexican border, there were only a few women tow pilots. Later we did all the towing operations there. In the morning we would fly out to the auxiliary field and fly our missions from there. In the back cockpit we carried a crew member, a tow operator, whose duty it was to let the target out. After it was out, we would call our flight and they would fly a pursuit curve, coming at us from

COURTESY ANNE NOGGLE

the opposite direction and starting to fire their .30-caliber machine guns at 45 degrees toward the target and stopping firing at 45 degrees from our tail. If they did this properly, we would not hear the guns—something to do with the way sound travels. Anyway, we were told that if we heard the guns, they were firing too close to us and we were to inform the gunnery students immediately to stop. The reason was obvious. On and off all day out there on the aircraft radio you could hear urgent feminine voices calling out, "Get off my tail!" There was no time for niceties.

I heard that Edie Keene had been killed when her AT-6 had structural failure and she couldn't get out. Then yet another classmate, Kay Dussaq, went in in bad weather. I don't

COURTESY ANNE NOGGLE

WASP trainees pose on a Vultee BT-13, an Army Air Forces basic trainer.

remember really talking about it among ourselves; we kept busy and we knew there would be losses. I think when you are doing something where there is risk, you don't let it into your conscious mind, at least I didn't. You make a pact with yourself that it might happen but probably not to you, and you are a fatalist—or you quit flying.

There are lots of little things I remember about my classmates. Like how Ikey could clasp her hands together, lean down with them forming a sort of loop, and jump through them without unclasping them. And Dottie, straight

out of Rock Springs, Wyoming, asserting herself, sticking up for what was right. She's even more assertive now. We all smile and listen to her while Doug, her husband who became an airline pilot after the war, smiles the most while she tells us how she feels about whatever it is—but she's 44-1 and loves us as we do her.

Summers in Sweetwater were hot, and we were allowed to move our cots outside between the barracks to sleep under the stars on those nights when the bays were stifling. Phyl and I often whispered after taps about our dreams of the future—she, married to a Navy pilot, dreamed of being an actress, and years later in Davenport, Iowa, I saw her star in the road show of *The Voice of the Turtle.*

I think we are becoming more like ourselves every year. Jeanette, our class secretary, becomes more patient with us and mothers us in the newsletter. We don't ourselves communicate so much as we tell Jeanette, and she translates and condenses it and is grateful when we send stamps to her in Ohio to make sure she keeps us together.

Many of us married during the war and a number of us continued flying for our

ARMY AIR FORCES PHOTO

Anne Noggle's camera captured GREY ALLISON HOYT DUNLAP, FRANCES THOMPSON HUNT, *and* SHIRLEY CHASE KRUSE *(left to right) at Sweetwater, Texas, near Avenger Field, where they graduated from training to enter military service as full-fledged WASPs.*

ARMY AIR FORCES PHOTO

COURTESY ANNE NOGGLE (3)

A solo trainee fills out reports while perched on the wing of a Stearman.

Pilots gather near a Beech AT-11 on the ramp before going aloft to tow targets for gunnery training (above). DORA DOUGHERTY STROTHER *(far right) earned a doctorate and entered the aerospace industry in the years after she towed targets in a Curtiss A-25 (right). Her introduction to Noggle's book reviews WASP history.*

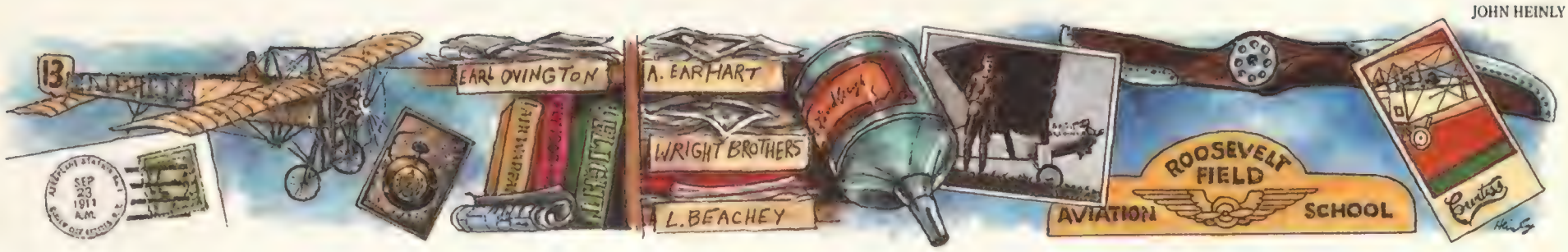
livelihood. But we could never go back to the way we were. The WASP experience changed us all forever. When I decided it was time to do this book, I wrote a statement about that to the WASPs when asking for their support. I quote from it:

For a long time I thought about making a photographic document of all of us as we look today. When we met in San Diego for our reunion in 1984, I arrived at registration and while waiting in line I looked and listened and I was filled with the wonderful sense of our vitality, one factor that makes us such a unique group. Then I thought about how few women have had the opportunity not only to fly for our Air Force, but to be thrown together willy-nilly in training and to know the bonding that usually is associated with groups who live and work in close proximity. This sense of belonging is all the more intense when the duties involve danger and risk. That makes it so rare with women. Add to that the kind of independent women we are and you have a portrait of a Women Airforce Service Pilot. I think we are extraordinary and I decided that I would take, not a group picture, but individual images. I feel that posterity will find these photographs of great interest. We may not be young any longer but we are very much alive.

Excerpted with permission of Texas A&M University Press.

MARY RETICK WELLS *levitating in 1986 (above). Though WASPs trained and flew like the military (right), they were classified as civil servants until 1979, when full veteran benefits were finally extended by Congress and the Department of Defense.*

JOHN HEINLY



Slim Hennicke's Basement

Browsing through Slim Hennicke's basement is like strolling inside his mind. Flicking on the overhead light, one perceives that every object is a cherished thought, a memory, a symbol of something significant to him. Most are neatly labeled and stacked on tables or stored in bookcases or file cabinets, but some sit in boxes, waiting to be rediscovered. Along the walls in the larger of the three rooms are shelves overflowing with magazines dating back to 1910, the piles topped with sheets of paper specifying the stacks' subjects: *L. Beachey, Col. Gabreski, A. Earhart, Earl Ovington, C. Lindbergh, Sikorsky, G. Loening, Glenn Curtiss, Air Mail, Wright Brothers, Parachutes, C. Chamberlin.* In other reaches of the basement lie a toy airplane hangar made of tin, a funnel used to fuel the *Spirit of St. Louis* at Long Island's Roosevelt Field before the Paris flight, a gold watch that early aerobatic pilot Lincoln Beachey gave his mechanic, and a wooden propeller from the Fokker that Admiral Richard Byrd flew over the North Pole in 1926.

Some collectors never set out to be collectors at all, but their love for a particular subject is strong enough to attract related objects to their doorsteps like homeless kittens. Before Mom can say "Clean up your room," a collection is in irreversible bloom. Hennicke, tall, straight, and slender as a spar, unknowingly became a collector in 1910 in Brooklyn at the age of eight, when a small monoplane flew overhead. "I knew from reading *Boy's Life* it was a Blériot," he recalls, "and the next day I bought a kit model of it made by the Wading River Model Airplane Company. When they saw my finished model the company gave me my first job: carving wooden propellers for the kits."

Young Carl's obsession caused him to miss school with some regularity. It was a matter of priority. "The early fliers were my heroes," he says. "Still are." When he did make it to class he spent most of his time folding paper airplanes, one of which sailed through the window of a room below and hit the principal in the ear.

There was no doubt whose airplane it was. After accepting the boy's apologies and learning about his new hobby, the principal loaned him a few aviation books and advised his parents to let him apply for work papers. "His brains are in his hands," he told them.

At age 16 Hennicke began work as an apprentice at the Ansonia Clock Works; then a job opened up nearby at Interallied Corporation, which imported surplus British aircraft to rebuild and sell in the United States. As a mechanic, Hennicke moved on to the Air Mail Service, Curtiss, Sikorsky, and RCA, servicing airplanes all over Long Island. Along the way he picked up Parachute Jumper License 13 and barnstormed New England in 1925 as a jumper and wingwalker.

In 1928, after a few lessons, Hennicke soloed an Eaglerock at Sheepshead Bay, the long-gone eastern Long Island airport he helped build. The next day the new pilot was taking passengers up and giving lessons himself. Still, "I've always been more interested in working as a mechanic than actually flying," he says. "I enjoy rebuilding a plane, then watching it fly."

By the time Hennicke was into yet another career as founder and instructor of the Triangle Tennis Club in Southampton, he had amassed a burgeoning aviation collection. With strays steadily arriving at his doorstep, he formed the Long Island Early Fliers Club in 1956 with an eye toward eventually building a museum to house his and others' regional aviation memorabilia. The club found space at Suffolk County Airport in 1970, and this year it plans to break ground for a museum nearby. Hennicke has, of course, willed the contents of his basement to the enterprise.

One of his goals in doing so is to dispel some myths of early aviation. Hennicke is a fact fanatic, and when he recites a bit of history you know it's a tale he's often told. He's particularly offended by one inaccuracy and its perpetuation by later writers who haven't done their homework.

About a dozen books in Hennicke's collection say that on the first airmail flight, a three-mile hop from Long Island's Garden City west to Mineola on September 23, 1911, Earl Ovington flew a Queen monoplane, an American-built copy of the Blériot. The same number of volumes say it was a French Blériot.

"The Queen Aeroplane Company was owned at that time by a retired Chicago stockbroker named McCornick," Hennicke says. "He was a little crooked." According to Hennicke, McCornick had offered Ovington the use of his two aircraft, both powered by Indian Motorcycle Company rotary engines. But Ovington made his airmail debut in a French Blériot, which used a Gnome rotary engine and was further distinguishable from the American version by its single set of cabane, or overhead, struts, rather than the Queen's two. Against the advice of his French mechanics, Ovington did test fly one of the Queens but damaged it in a forced landing after the engine quit. The second crashed more dramatically at the hands of an eager pilot unacquainted with the forceful torque characteristics of rotary engines. Hennicke says McCornick paid reporters covering the airmail flight to write enthusiastically of the Queen airplane; later, an ad even claimed that an Indian Motorcycle engine had powered the first airmail flight.

"It just wasn't true," says Hennicke, but setting the record straight has proved to be a lonely battle. He says one historian he contacted showed little enthusiasm or gratitude and never published a correction. Others seem indifferent to an old man's cause. "Maybe it's not important which airplane Ovington flew," he says, but it's clear he doesn't believe that.

These days, Hennicke, now 88, spends much of his time readying his collection for transfer to its new home. Just recently he quit giving tennis lessons, and lately he's not always able to summon the energy to answer phone and mail inquiries. He asks that well-meaning people understand that. Visitors to the future Long Island Early Fliers Museum will appreciate what he has saved for them, but I wish they could have visited his basement, talked to this gentle man, and heard firsthand the memories his collection represents.

—Russell Munson

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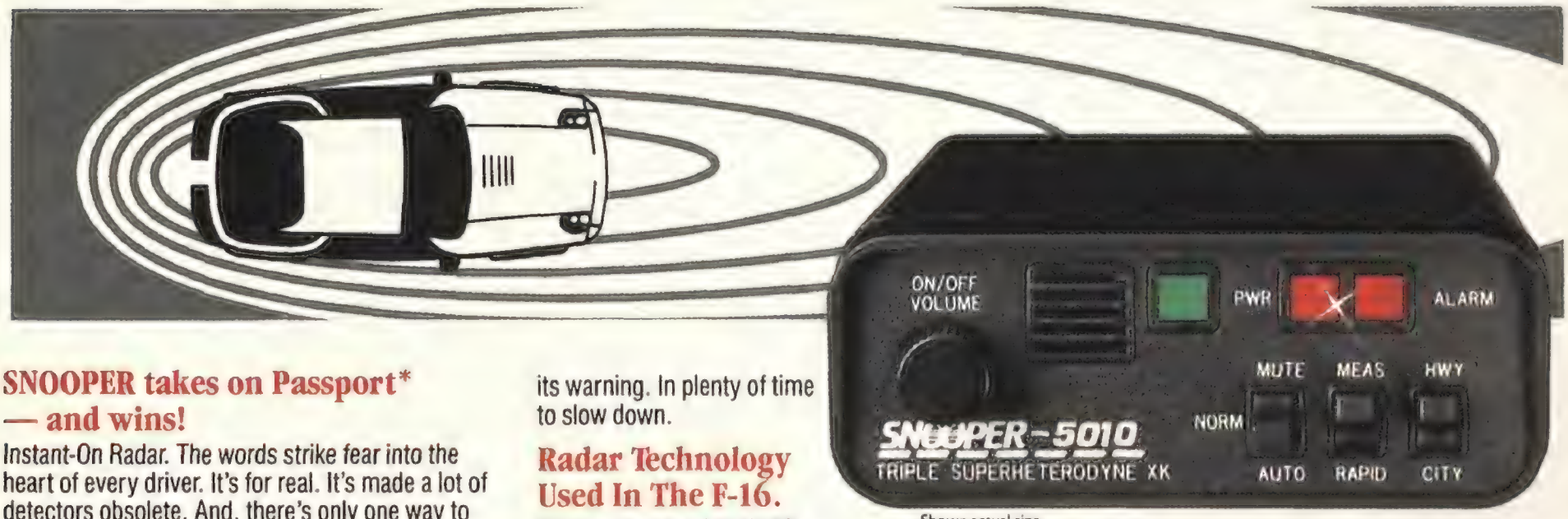

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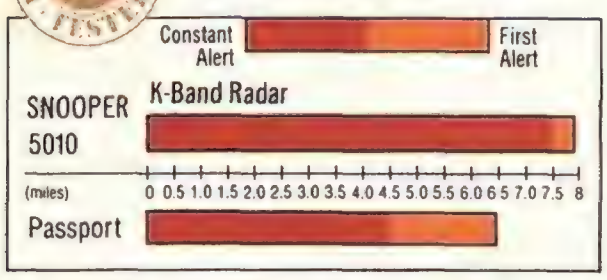

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***The Battle of Britain: The Greatest Air Battle of World War II** by Richard Hough and Denis Richards. W.W. Norton & Co., 1989. 413 pp., b&w photos, $29.95 (hardbound).*

***Their Finest Hour: The Battle of Britain Remembered** by Philip Kaplan and Richard Collier. Abbeville Press, 1989. 224 pp., b&w and color photos, $49.95 (hardbound).*

It was on June 18, 1940—50 years ago—that Winston Churchill announced that "the Battle of France is over. I expect that the Battle of Britain is about to begin." Four months later the battle was won: on October 12, Hitler officially announced the "postponement" of the invasion of Britain.

Not even the war in Vietnam, which was fought on television in living rooms around the world, was as intimately visual as the Battle of Britain. My parents and I watched the battle from deck chairs on the lawn while sipping tea. Thousands watched from office roofs, feeling safer outside than under concrete. Pubs near fighter stations kept a tally of the score on blackboards.

As Royal Air Force Group Captain Peter Townsend acknowledges in his introduction to Philip Kaplan and Richard Collier's *Their Finest Hour*, the combatants were more alike than different. As an 18-year-old, Townsend entered the RAF "driven only by a longing to fly," he writes. "Luftwaffe pilots, long after the war was over, told me it was the same with them—the sound, the sight, the touch and the smell of an aeroplane had an irresistible appeal to all senses. More is the pity that it led us to kill each other."

Perhaps inevitably, both *Their Finest Hour* and Richard Hough and Denis Richards' *The Battle of Britain* lack the literary style of Len Deighton's masterly account of the battle, *Fighter* (Ballantine, 1977); Deighton was also more evenhanded in his treatment of the Luftwaffe. Hough and Richards' book, however, is unquestionably thorough. The book includes an enormous amount of first-person accounts, with sometimes funny, sometimes wrenching anecdotes that help bring the battle to life.

In one, a sergeant in the Women's Auxiliary Air Force who was charged with monitoring radio transmissions of German pilots recalls that she had just reported on the regular appearance of a reconnaissance pilot when he was intercepted by Spitfires and shot down in flames. "He was unable to get out and we listened to him as he screamed and screamed for his mother and cursed the Fuehrer," she recounts. "I found myself praying: 'Get out, bail out, oh please dear God, get him out.' But it was no use. We heard him the whole way down until he fell below reception range. I went out and was sick."

The profusely illustrated Kaplan-Collier book offers a sketchier version of the battle but succeeds in recreating its atmosphere. Although the brief text is both entertaining and serious, *Their Finest Hour*'s strong suit is its feast of graphics. The pages are scattered with an expert selection of black-and-white historical photographs, color photos of significant places and artifacts, advertisements, paintings, and even snippets of popular songs, poetry, and pilots' diaries and memoirs. (One disappointment is the cover; its modern color photo of a male model wearing RAF surplus seems more appropriate for an aviation catalog than a work of history.)

As both books make clear, the odds at first seemed greatly stacked against the British. But although the Luftwaffe began the battle with many more airplanes and pilots, the RAF had the advantage of flying over home soil. In addition, Britain had a radar advantage, and had cracked Germany's Enigma encoder: Air Chief Marshal Hugh Dowding was well informed of most of the Luftwaffe's radio traffic.

The average RAF pilot, however, was just over 20 years old and had virtually no combat experience, whereas the average German pilot was a four-year veteran, often with Spanish civil war experience. And until the RAF copied the Luftwaffe's *Schwarm*—four aircraft flying as two pairs—it used outdated flight tactics.

Eventually, Townsend and his comrades devised their own tactic: the head-on attack, with guns adjusted to converge at 250 yards instead of 400. This meant that a Hurricane or a Spitfire would approach a 109 at a closing speed of nearly 300 yards a second, leaving only about a second for its pilot to get away after firing. Collisions were common; as a British pilot who witnessed one reminisces in the Hough-

Richards book, it "caused me to realise my young life and its future, if any, had jumped into another dimension." But the tactic had a devastating effect on enemy formations.

In painting their respective pictures, both *The Battle of Britain* and *Their Finest Hour* successfully capture the spirit of this great air battle—a battle won by mostly school-age boys whose influence on history will continue many more years into the future.

—The latest of Russell Warren Howe's 15 books include Flight of the Cormorants *(a novel) and* The Hunt for "Tokyo Rose."

Only a few will own . . . ***So Few,*** perhaps the ultimate Battle of Britain book. To commemorate the battle's 50th anniversary, the Royal Air Force Benevolent Fund is publishing 401 copies, printed on gold-tipped paper with covers of "selected Chieftain goatskins, dyed the exact shade of [the] RAF wartime uniform." Containing reminiscences of 25 surviving pilots, the first volume will be presented to the Queen; the remainder can be had for a princely £1,600 apiece—that's nearly $2,800.

Their Finest Hour: The Battle of Britain *by Lawrence Holland. Lucasfilm Games, 1989. Available for IBM PC, XT, AT, PS/2, Tandy. 512 RAM, color monitor. Joystick or mouse recommended. Reviewed on an IBM XT compatible with a Princeton Graphics Ultra 16 color monitor. $59.95.*

This game was new to me—this game of life and death in the air over France and England. The margin for error was slim, as my friend Heinz had found out this morning. Now I was back in the air, the bright afternoon sun gleaming on the other Stukas of my *Staffel.* Once again I would attack. As the engine hummed I looked around. Not as many of us now. The murderous flak of the British destroyers had taken their toll.

My stomach churned as we approached several ships in the English Channel. Bursts of flak broke on the horizon, and I reflexively checked the straps of my parachute. I could see the red shell explosions and began to sweat. I dropped quickly as shells from one of the destroyers streaked at me. I sighted on her superstructure and, at 3,000 feet, released my bomb load. I heard a terrific explosion and looked back after leveling my machine. Flames had sprung up, followed by a column of smoke. Moments later the ship was gone—another souvenir for the channel floor.

The flak was intense as I raced toward the airfield in occupied France I now called home. Get home. Get home! That was all that mattered. I had only 40 miles to go when I saw a speck in the distance. Then it grew more distinct: two Spitfires! I fired at one and it fragmented in the air. A parachute appeared as the machine crashed into the channel with a huge splash. I could hear my rear gunner's machine gun pounding away. Then it was silent. When I looked around once again, yet another Fighter Command airplane hurtled toward the water, trailing bits of flame.

Okay, okay, so I wasn't wearing a parachute. That was about the only poetic license I took in the above paragraphs. As for the rest, well, that was an example of only one of the missions I've flown while playing "Their Finest Hour: The Battle of Britain."

"Their Finest Hour" is a game of both air combat and campaign strategy covering the entire duration of the battle. But don't let the idea of strategy frighten you off. Above all, this game is an excellent air-to-air (and air-to-ground) combat simulation. And it's not just fun. It's lots and lots of fun. This is a game you will fly again and again. It offers such a variety of missions and aircraft—both RAF and Luftwaffe—that you could play for weeks without duplicating a flight.

"Their Finest Hour" comes with an extensive reference-historical manual of nearly 200 pages, an eight-page quick reference, a radio signal cipher wheel, and four standard 360K double-sided double-density diskettes. The well-written manual gives a historical overview of the battle and its significance, the weapons involved, principles of flight and tactics, and a color map of the battle area, as well as the game's instructions. A couple of pages of indexing for both the historical parts and the instructions would have been helpful.

The diskettes can be easily installed onto your hard drive with the installation programming on the first disk. You will need about 1.3 megabytes of free disk space, but the game's worth every last byte. While you can run from the floppy disks, I recommend the hard drive. Not only is access time much faster, but you won't have to keep swapping disks.

To begin the game you select from a variety of choices, including flying individual combat flights, creating a custom mission of your own, and reviewing combat "film" and individual pilots' records. Within each type of mission the difficulty can be fine-tuned in a variety of ways. You can select your own fuel, ammunition, and battle damage levels, as well as the skill level of your opposition.

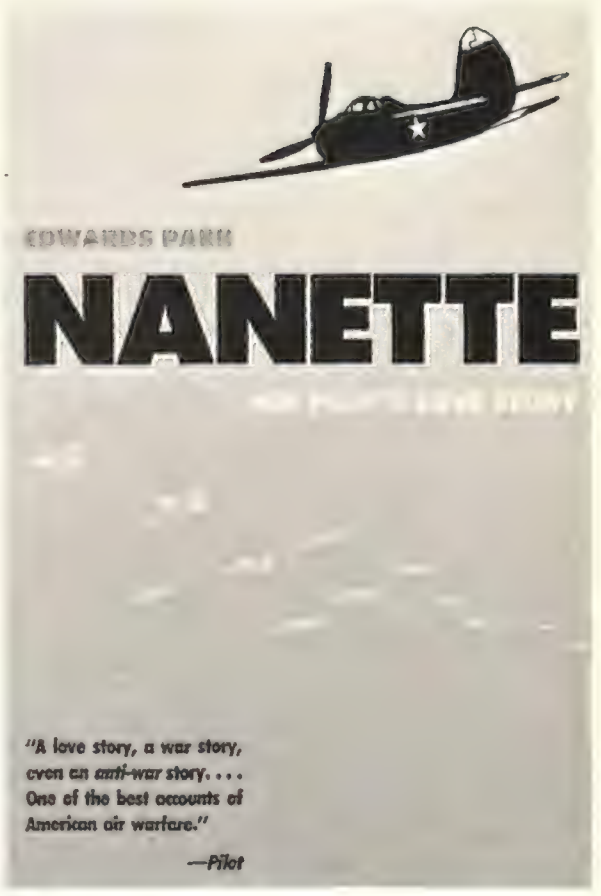
At any time during the mission you can consult your flight map, which is updated periodically with reports of friendly and enemy activity and targets. It's important to keep track. I didn't once. After escaping from a swarm of British fighters I was pretty proud of my abilities at both flying and evading the enemy. I flew on and on until I was finally nearing the French coast. Only I had been flying west, not east, and the coast was the English countryside near Exeter.

And don't forget to tune your radio. This is easily done by using the cipher wheel, which provides the key to the radio tuning for that day's mission. Forget, and you're completely alone out there.

Lucasfilm Games has paid an enormous amount of attention to detail. When you cross the English coast you will see the array of 350-foot towers that were part of the British radar network. Dive-bombing in the channel reveals not only flak bursts but anti-aircraft fire from the ships below. The aircraft are authentically detailed, nose to tail. The fine detail carries into the cockpit of each fighter or bomber.

With a retail price of about $60, the game is more expensive than most. But for sheer fun, I think it's worth it. Midnight may well find you too in front of your computer, facing work in the morning and telling yourself, "Just one more flight before bed."

—Steve Gracie, a financial administrator for the Unisys Corporation in Reston, Virginia, is an avid player of military video games.



***Nanette: Her Pilot's Love Story** by Edwards Park. Smithsonian Institution Press, 1990. 186 pp., $9.95 (paperback).*

Soon after arriving in Port Moresby, New Guinea, as a freshly minted World War II fighter pilot, the impressionable young Edwards Park fell deeply in love. The sophisticated, frustrating, and flirtatious object of his affection was a Bell P-39 he named Nanette.

First published in 1977 and now available in paperback, *Nanette* traces the tortuous route of this love affair, with cameo appearances by the other men and machines of the Gopher Squadron. The author, a *Smithsonian* columnist and *Air & Space/Smithsonian* contributor, has occasionally expanded on incidents first described in *Nanette* for this magazine. Readers who enjoyed those columns will find *Nanette* an endearing story.

—Patricia Trenner is the departments editor of Air & Space/Smithsonian.

***Blue Angels: A Backstage Pass** and **Find Your Way Back: A Salute to the Space Shuttle**, produced by James M. Cross. Cabin Fever Entertainment, Inc. (1-800-553-3837), 1989. Approximately 30 minutes each, $19.95 apiece.*

Essentially music videos for air and space buffs, *Blue Angels* and *Find Your Way Back* aim at being pure fun. Presumably inspired by the success of *Top Gun*, these lighthearted yet inspiring videos couple

scenes of air- and spaceflight with rock music: among other segments in *Find Your Way Back,* the training of shuttle astronauts unfolds to Steve Winwood's "Back in the High Life" and the space shuttle goes about its business to Pat Benatar's "All Fired Up." *Blue Angels* introduces its subject accompanied by Tom Petty's "Deliver Me" and concludes with spectacular flying sequences set to Lionel Richie's "Dancing on the Ceiling."

Between musical sequences on both tapes the pilots and astronauts talk about what attracted them to their profession and how they meet its demands. The interviews are more effective in the shuttle film, in which the astronauts appear more relaxed before a camera, but are an asset to both, adding an unintrusive documentary air to the tapes' reasonably priced fun.

—Karen Jensen is an associate editor of Air & Space/Smithsonian.

***Skyfire '89: The Champions,** produced and directed by Jim Mitchell. Showmasters/Mitchell Productions, Inc. (1-800-852-2330), 1990. Approximately 90 minutes, $49.95.*

Jim Mitchell's latest video offers footage shot at the 1989 National Championship Air Races in Reno, Nevada, emphasizing the unlimited class, which is made up of

modified World War II propeller-driven fighters. In this edition, former test pilot and airshow celebrity Robert A. Hoover, who has acted as starter for the unlimited events for years, shares the emcee role with Mitchell.

The producers have wisely heeded their viewers' advice after previous efforts. This time they trim the narration and simply let the camera linger on the action. Aside from one explanation of the use of cooling spray to carry away heat from the airplane's radiators, the film offers little insight into the lore of racing or the tactics winning pilots use. The race pilots themselves seem to enjoy talking more about how much they like each other, anyway.

Those with video equipment capable of reproducing stereo will enjoy the digitally recorded sounds of fighters passing at full throttle and at speeds of nearly 450 mph. Cameras mounted aboard airplanes also offer an unusual view of the course. For anyone who can't make it to the Reno air races, this video is perhaps even better than being there.

—George C. Larson is the editor of Air & Space/Smithsonian.

***Almanac of Soviet Manned Space Flight** by Dennis Newkirk. Gulf Publishing Company, 1990. 391 pp., b&w photos and line drawings. $29.95 (hardbound).*

"Timber wolves scratch at a space capsule's hatch . . . a cosmonaut is lost in space—almost . . . close encounter with a meteor temporarily blinds cosmonauts." These are some of the teasers appearing on the jacket of Dennis Newkirk's new chronology of the Soviet manned space program. Fortunately, the book goes well beyond such hype as it tells how the Soviets have methodically collected the world's largest database on manned spaceflight.

Gathering his information from official Soviet press reports and accounts in Western journals, Newkirk gives a concise account of each flight, including line drawings of vehicles involved, names of crews and backups, mission activities, orbital parameters, and launch, landing, and docking times. A particularly useful feature is the brief summary that appears in bold type below each mission name, making it easy to locate when the first foreign guest cosmonaut flew, for example, or when the first quadruple docking took place.

Although the book is aptly called an almanac and should be classed as a reference work, the author has succeeded in making it more than a dry recitation of facts. The book is well written, well documented, and loaded with information.

Yet the main attraction of this book is that it exists at all. To my knowledge, nobody in the West has ever compiled for publication a mission-by-mission log of Soviet manned and man-related flights. And for good reason. Detailed information on early Soviet space activities has been difficult to find and often unreliable, as James E. Oberg, a U.S. expert in Soviet space programs, points out in the foreword. It has taken many years of hard work by Western-based Soviet space watchers to make sense of the bits of information emanating from Moscow. And there's still much to learn, including detailed accounts of launch accidents, numbers of test flights, and the composition of backup crews.

In fact, only with the advent of *glasnost* has information been released about Soviet plans to land a man on the moon before the United States. Some of this new data renders parts of Newkirk's book obsolete, although the majority of the work is still accurate.

While the author does not make explicit value judgments about the Soviets' space program, he keeps the workings of the U.S. program (and the U.S. reaction to Soviet developments) well within the reader's field of vision. And he reminds us often that while U.S. technology has generally remained ahead of Moscow's, it is the Soviets who, by keeping to a conservative course and reusing proven methods and vehicles, are approaching the ability to conduct a mission to Mars.

—Seth Arenstein is the editor of Soviet Aerospace, *a journal that monitors Soviet military and space developments.*

Credits

Five for a Nickel. Dave Noland recently wangled the original art for his favorite Wings card: number 72, the British Venom fighter.

Looking for *Langley.* Vice Admiral John T. Hayward is a consultant for the Charles Stark Draper Laboratory in Cambridge, Massachusetts.

Footnote. Currently working as a technology and foreign affairs consultant, Neil Carothers III was a test pilot at Patuxent River Naval Air Test Center during World War II.

Satellite Sleuths. Doug Stewart is a writer who lives in Massachusetts.

Inside Star City. James E. Oberg, a space engineer living in Houston, has published on all aspects of spaceflight.

The Last of the Few. Charles Fox lives in California. He has written for *Car & Driver* and *Playboy* and is currently writing a memoir of his parents' marriage for Little, Brown. He was assisted in his research and writing by James Fox, Susan Bower, Lisa Reinhardt, and Seth Mortimer.

Further reading: *The Battle of Britain,* Richard Hough and Denis Richards, Norton, 1989.

Their Finest Hour, Winston Churchill, Houghton Mifflin, 1949.

The RAF at War, Ralph Barker, Time-Life Books, 1981.

Improbable Journey. Dan B. McCarthy is a photojournalist who lives in St. David, Arizona.

Further reading: "Around the World with the Flivver Fliers," George Truman and Clifford Evans, *Collier's,* February 7 and 14, 1948.

300 Billion Watts, 24 Hours a Day. Linda Shiner is the senior editor at *Air & Space/Smithsonian.*

Things In Wings. George C. Larson is the editor of *Air & Space/Smithsonian.*

Return of the WASPs. A former curator of photography for the Fine Arts Museum in Santa Fe, Anne Noggle is a professor of art at the University of New Mexico.

Slim Hennicke's Basement. Aviation photographer Russell Munson is the author of *Skyward: Why Flyers Fly* (Howell Press, 1989).

Calendar

June 1–3
Southwest Airlines Airshow. Double Eagle II Airport, Albuquerque, NM, (505) 247-7469.

June 15–17
United States Pilots Association Fly-In. Aviation safety seminars. Clarion Hotel-Englewood, Denver, CO, (303) 753-1480.

June 16 & 17
Open Cockpit Weekend. New England Air Museum, Bradley International Airport, Windsor Locks, CT (203) 623-3305.

June 21–23
Airliners International Convention. Display, swap, and sell air transport memorabilia. Guest speaker: Tex Johnston, a retired Boeing test pilot. Red Lion Hotel, Seattle-Tacoma International Airport, Seattle, WA, (503) 652-2225, ext. 209.

June 30
Racine on the Lake Lakefront Airshow. Thunderbirds, skydiving, and vintage aircraft. Lake Michigan, Racine, WI, (414) 634-3293.

July 13–23
Dayton International Air and Trade Show. Thunderbirds and Golden Knights. Dayton International Airport, Vandalia, OH, (513) 898-5901.

July 14–15
Airshow Rockford. Warbirds. Greater Rockford Airport, Rockford, IL, (815) 226-7674.

July 16–19
Joint Propulsion Conference. Latest developments in aerospace and air-breathing propulsion. Marriott World, Orlando, FL, (412) 772-7131.

July 21 & 22
Aviation Expo. Warbirds and radio-controlled aircraft demonstrations. Van Nuys Airport, CA, (818) 785-8838.

"The Satellite Sky" Update/18

These regular updates to **"The Satellite Sky"** chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

New launches

90 to 300 MILES

- Cosmos 2060 3-14-90 TT
- Cosmos 2062 3-22-90 PL
- Progress M-3 2-28-90 TT
- SDIO-RM 2-14-90 CAC

300 to 630 MILES

- Cosmos 2061 3-20-90 PL
- Intelsat 6 3-14-90 KSC
- Nadezhda-2 2-27-90 PL
- Offeq-2 4-3-90 NEG
- Okean-2 2-29-90 PL
- Pegsat 4-5-90 B-52
- SDIO-LACE 2-14-90 CAC

630 to 1,250 MILES

- Cosmos 2064-71 4-6-90 PL
- DEBUT 2-7-90 TAN
- JAS 1B 2-7-90 TAN

6,200 to 13,700 MILES

- GPS-7 3-26-90 CAC

21,750 to 22,370 MILES

- Asiasat 4-7-90 XI

Deletions

90 to 300 MILES

Cosmos 2052 down 1-22-90	Cosmos 2057 down 3-19-90	Soyuz TM-8 down 2-19-90

Launched but not in orbit

90 to 300 MILES

STS-36 USA research	2-28-90	down 3-4-90

Inoperative but still in orbit

300 to 630 MILES	21,750 to 22,370 MILES
Cosmos 1816	Westar 3

Forecast

In the Wings . . .

Battle of Britain II. A view from the other side—Luftwaffe pilots tell their battle tales.

Life on Mars? For a lot of people, the Vikings' negative findings provided the last word on this provocative subject. But there's life in the debate yet.

An Exchange of Missiles. In this case, a peaceful one, as the United States and the Soviet Union exchange Pershing IIs for SS-20s. Greater awareness of these weapons and their dangers should be the result in both countries.

Aviation Consumer Action Project. Can two guys in Washington have any effect on the way the airlines run their industry?

Spearing a Comet. A scenario for a future scientific mission has the comet playing the white whale to a spacecraft's Ahab.

"For years we were building the master models for our plane parts by machining out aluminum templates, then filling them with wire or plaster to shape them. That took a lot of time and hands-on labor.

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—Elmer Armstrong, Branch Manager Tool Engineering, Advanced Combat Aircraft Program

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